UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

DEC 14 2009

12/09/09

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Francisco Trejo
President
Unicorn Management Consultants, LLC
52 Federal Road - Suite 2C
Danbury, CT 06810

Re: Lehigh Valley Railroad Derailment Superfund Site
Le Roy, New York

Dear Mr. Trejo:

This letter pertains to the Remedial Design Work Plan (RDWP), dated October 13, 2009, as such document was amended by a letter (Amending Letter) dated December 7, 2009, and as such Amending Letter and such RDWP were submitted to the U.S. Environmental Protection Agency (EPA) for approval by Unicorn Management Consultants, LLC (UMC) on behalf of Lehigh Valley Railroad Company (LVRR).

Please be advised that the EPA has reviewed the RDWP and the Amending Letter, and that the EPA hereby advises UMC that the RDWP as revised by the Amending Letter is approved without further modification.

If you have any immediate questions or comments on the information contained in this letter, you may contact me at 212-637-4280.

Sincerely yours,

Paul J. Olivo
Project Manager
Lehigh Valley Railroad Derailment Superfund Site

bcc: J. Moras - NYSDEC
M. Wieder - USEPA
E. Schwetz - HDR

52 Federal Road, Suite 2C
Danbury, CT 06810
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www.unicornmgt.com

Unicorn Management Consultants, LLC

December 7, 2009
Refer to OP-2443

Paul J. Olivo
U.S. Environmental Protection Agency, Region 2
Emergency and Remedial Response Division
290 Broadway, 20th Floor
New York, New York 10007-1866

Subject: Remedial Design Work Plan
Lehigh Valley Railroad Derailment Superfund Site, Leroy, NY
Index No. CERCLA-02-2006-2006

Dear Mr. Olivo:

This letter has been prepared by Unicorn Management Consultants, LLC ("UMC") on behalf of Lehigh Valley Railroad Company ("LVRR") in response to comments by the New York State Department of Environmental Conservation ("NYSDEC") and the U.S. Environmental Protection Agency's ("USEPA's") contractor, HDR, Inc. ("HDR"), on the RDWP submitted to USEPA on October 16, 2009. UMC is responding to NYSDEC's and HDR's comments contained in the following two documents:

1. Email from Jim Moras (NYSDEC) to Paul Olivo (USEPA) transmitted November 3, 2009 forwarded to UMC on December 1, 2009.
2. Email from Edward Schwetz (HDR) to Paul Olivo (USEPA) transmitted October 26, 2009 forwarded to UMC on December 1, 2009.

NYSDEC's and HDR's comments are repeated below in italics followed by UMC's response.

NYSDEC's November 3, 2009 Comments

1. Relative to how Unicorn modified the document to address comment/response #5, when they discharge the water to the ground surface (to recharge back into the groundwater), they need to make sure the water infiltrates and does not run off; this can be done in a number of ways, including, but not limited to digging a shallow recharge pit (and covering it after completion) and/or moderating the flow rate to prevent surface runoff.

Also, once again it is recommended that they conduct groundwater sampling for VOCs using passive diffusion bag samplers; this would prevent the generation of development/purge water.

UMC will ensure that any discharge of water to the ground surface will be done in a manner that allows infiltration and does not cause surface run-off.

It is UMC's intent to use passive diffusion bag samplers in existing wells once USEPA's Monitored Natural Attenuation sampling requirements are met (refer to Section 5 of RI/FS Work Plan Addendum 2, dated October 30, 2009)

2. With respect to soil sampling within the original source area to define the remedial boundaries for soil removal, the June 4, 2007, work plan proposed to use PID readings to determine whether soil samples will be analyzed by a mobile laboratory or will be presumed to be contaminated and designated for remediation. In the response to comments document, Unicorn Management proposes to use an initial PID screening level of 3.5 ppmv calibrated using TCE gas to determine whether soil samples will be analyzed in a laboratory. However, the rationale for selecting 3.5 ppmv as a screening level is not provided and is needed in order to understand how this screening level will properly guide the soil sampling plan to define the limits of TCE contaminated soil required to be remediated.

The relationship between PID field screening results and TCE concentrations as determined by laboratory analyses is complex and subject to many unknown and/or uncontrollable variables including; the TCE concentration, organic content, temperature, moisture content and permeability of the soil, and, ambient air temperature and humidity. UMC selected 3.5 part per million by volume (ppmv) as the ***initial*** screening level based on professional judgment. As stated in the RDWP, the screening level may be adjusted based on analytical results. The salient point here is that under the proposed work a soil sample is presumed dirty, i.e., presumed to contain greater than 7.0 ppm TCE, unless proven otherwise by laboratory analysis. Field screening, as proposed, is simply being used to save time and money on unnecessary analyses in areas where contamination above the standard is evident.

3. The June 2007, work plan did not include a Community Air Monitoring Plan (CAMP) to be implemented during ground intrusive work. In response to a comment requesting that a CAMP be implemented during the remedial design activities, Unicorn Management indicated that the remedial design work plan includes "minimally invasive/disruptive ground penetrations." Further, Unicorn Management indicated that the "Site Health and Safety plan includes provisions to monitor the breathing space for VOCs and dust at drilling operations" and that these measures are "protective of the workers and by extension will be protective of the community." This response is not acceptable and it is recommended that a CAMP be implemented during all ground-intrusive work (including sub-surface sampling and monitoring well installation). The New York State Department of Health's Generic Community Air Monitoring Plan is attached, to be used for guidance in creating and incorporating a CAMP in the remedial design work plan.

UMC will implement the New York State Department of Health's Generic Community Air Monitoring Plan when conducting ground-intrusive work during the Remedial Design Investigation UMC will record, maintain and make available for review all air monitoring data collected during CAMP implementation and will duly report any excursions from the generic action levels.

HDR's October 26, 2009 Comments

It appears that UMC may not have understood my first comment under Section 3.1.1. Based on the response provided by UMC, it appears that TCE will be the gas used for calibrating the PID. UMC should confirm whether TCE is the calibration gas or if the PID will be calibrated using a TCE equivalent gas. If the latter, the specific calibration gas should be identified. The equipment manufacturer and the model number of the PID should be identified.

The calibration gas will be 10 ppmv Trichloroethene. UMC sees no need to identify the PID manufacturer and model number at this time. This information will be documented in field notes.

Regarding Jim's comment below, I agree that the discharge of groundwater should be in a manner where it is allowed to infiltrate and should not be allowed to run off. Diffusion bag samplers would also minimize the amount of purge water generated.

See response to NYSDEC Comment No. 1 above.

If you have any questions regarding this letter, please call me at 203-205-9000, ext. 11.

Sincerely,
UNICORN MANAGEMENT CONSULTANTS, LLC

Francisco Trejo
Project Coordinator
Lehigh Valley Road Derailment Superfund Site

cc: M. Wieder, Esq (w/o encl.)
J. Moras, P.E.
E. Schwetz
B. Stonelake, Jr., Esq.
K. Hanlon

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Unicorn Management Consultants, LLC

REMEDIAL DESIGN WORK PLAN

Lehigh Valley Railroad Derailment Superfund Site
LeRoy, New York
Index Number CERCLA-02-2006-2006

LEHIGH VALLEY RAILROAD COMPANY
CINCINNATI, OHIO 45202

Prepared By:

Unicorn Management Consultants, LLC
52 Federal Road, Suite 2C
Danbury, CT 06810

October 13, 2009

DOCUMENT AUTHORIZATION FORM

REMEDIAL DESIGN WORK PLAN

Lehigh Valley Railroad Derailment Superfund Site

LeRoy, New York

Index Number CERCLA-02-2006-2006

LEHIGH VALLEY RAILROAD COMPANY

CINCINNATI, OHIO 45202

Prepared By:

Unicorn Management Consultants, LLC

52 Federal Road, Suite 2C

Danbury, CT 06810

October 13, 2009

AUTHORIZATIONS:

________________________ 10/13/09

Kerry M. Hanlon, P.G., LEP — Date
Director of Operations – UMC, LLC
Lehigh Valley Railroad Derailment Superfund Site

________________________ 10/13/19

Francisco Trejo — Date
President – UMC, LLC
Remedial Project Coordinator
Lehigh Valley Railroad Derailment Superfund Site

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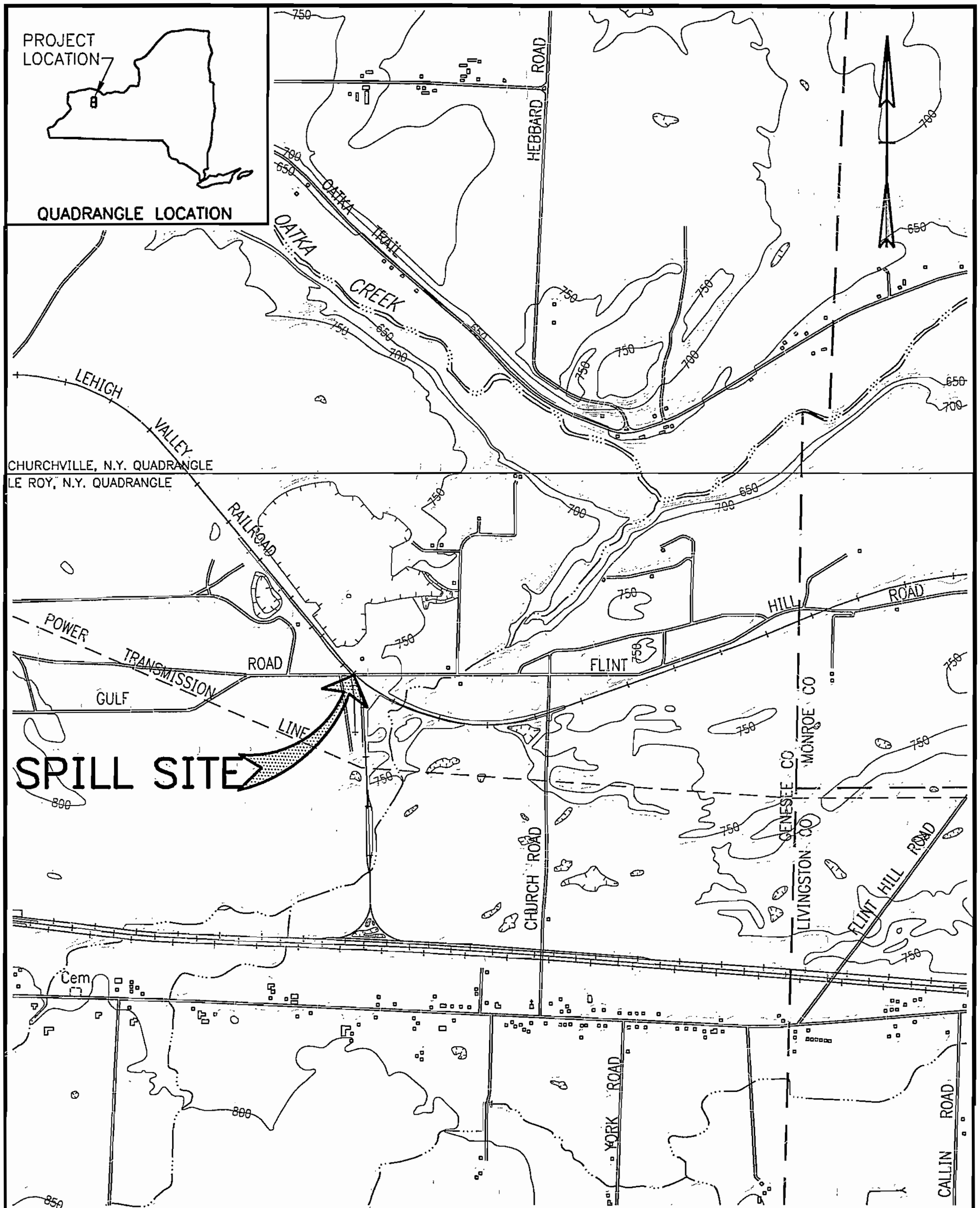
1 INTRODUCTION

1.1 PROJECT DESCRIPTION

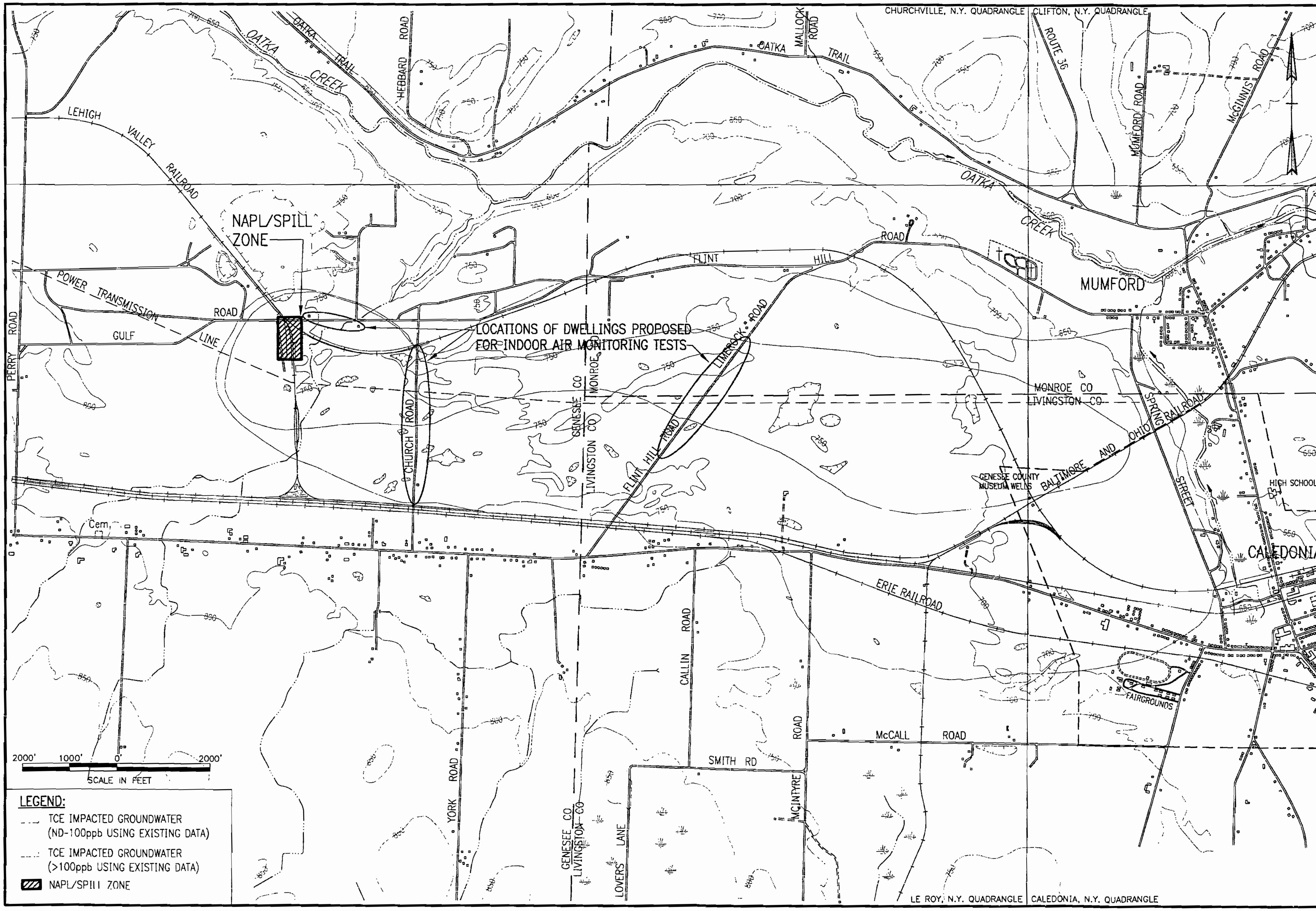
Lehigh Valley Railroad Company (hereinafter, "LVRR") is the respondent of the Settlement Agreement and Order on Consent for Pre-Remedial Design Investigations, Remedial Design, and Remedial Investigation/Feasibility Study, Index Number CERCLA-02-2006-2006 (hereinafter, "SA") for the Lehigh Valley Railroad Derailment Superfund Site located in Genesee, Monroe and Livingston Counties, near the Town of LeRoy, New York (hereinafter, the "Site"), which was issued by the United States Environmental Protection Agency (hereinafter, "EPA"), effective date October 6, 2006. Refer to Figure 1-1 and 1-2 for the Location and Site Maps. The SA requires LVRR to undertake Pre-Remedial Design (Pre-RD) investigations as described in the Statement of Work (SOW) and perform the Remedial Design (RD) of the Soil Vapor Extraction (SVE) System selected in the Record of Decision (ROD). The ROD and SOW were incorporated into the SA as Appendix A and Appendix B, respectively. As required by the SA, this RD Work Plan has been prepared to provide a detail of the Pre-RD activities and design of the SVE remedy. The format of this RD Work Plan is consistent with the items specified in Sections IV, V, and VI of the SOW.

1.2 BACKGROUND

Information concerning this Site has been summarized in the EPA-Approved Final Work Plan for Remedial Investigation/Feasibility Study prepared by Foster Wheeler for EPA on February 13, 2002 (RI/FS Work Plan), the New York State Department of Environmental Conservation (NYSDEC) Remedial Investigation (NYSDEC RI) Report prepared by Rust Environment and Infrastructure (RUST) in October 1996, the Draft Ex-Situ Soil Vapor Extraction and In-situ Bedrock Vapor Extraction Pilot Test Report prepared by IT Corporation (IT) on April 9, 1999, and EPA's May 15, 2002 memorandum. These documents are referenced for background purposes only. UMC and LVRR make no representations regarding the accuracy of the statements and data contained in the documents.



REVISION NO.		PROJECT	LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE LE ROY, NEW YORK	Unicorn Management Consultants, LLC 52 FEDERAL ROAD DANBURY, CT (203) 205-9000	PROJECT # 2030-100 FILENAME: SPILL SITE
NO.	DATE	DRAWING	SPILL SITE LOCATION U.S.G.S. QUADRANGLE CHURCHVILLE, NY 1950, PHOTOREVISED 1978 U.S.G.S. QUADRANGLE LE ROY, NY 1950, PHOTOINSPECTED 1976		SCALE: 1"=2000' DATE: 10/31/06 BY: AD CK: FIGURE # 1-1



REVISION NO.	
NO.	DATE

PROJECT: LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LE ROY, NEW YORK

DRAWING: SITE LOCATION PLAN

Unicorn Management Consultants, LLC
52 FEDERAL ROAD
DANBURY, CT
(203) 205-9000

PROJECT # 2030-100	
FILENAME: Location Plan	
SCALE: 1" =2000'	DATE: 4/23/07
BY: AD	CK:
FIGURE # 1-2	

2 DESIGN TEAM AND MANAGEMENT PLAN

2.1 DESCRIPTION

The intent of this section is to describe the LVRR Remedial Design Professional Design Team and management structure, including organizational charts and descriptions of applicable responsibilities that will be held by various team members during the Remedial Design phase of this project. Management of the physical aspects of the site will also be addressed in this section.

2.2 PROJECT ORGANIZATION

The LVRR Remedial Design Professional Design Team is outlined on the organizational chart (see Figure 2-1). A brief description of the responsibilities for each project member is presented below.

- Francisco Trejo has been designated as Project Coordinator for the site by letter from LVRR dated October 20, 2006. Mr. Trejo will be the liaison between UMC and LVRR.
- Kerry Hanlon, P.G. will be the Project Manager for UMC. He will be responsible for overall project management and will be the primary contact person for all regulatory personnel and other interested parties. He is also responsible for data reduction which involves review of validated data to determine if additional samples/analyses are required. In addition, he will coordinate site audits throughout the duration of the field activities. Mr. Hanlon will be responsible for Site Characterization, including Geologic and Hydrologic Studies for the groundwater and stream (as needed). Mr. Hanlon will also direct the field sampling efforts within the soil, bedrock, and streams.
- Corporate Health and Safety Officer (To Be Announced) –The Corporate Health and Safety Officer will be responsible for overseeing the development and implementation of the site-specific health and safety plans for all site activities.
- Roy Prescott (or his designee) will be the Site Supervisor and team leader during remedial design investigations, maintenance and monitoring activities. He will hold ultimate on-site responsibility for the proper execution of all site work and authorization of unplanned contingencies (including subcontractor's tasks). He will also be responsible for site coordination with objectives, prioritization of site activities, and completion of all progress reports. Mr. Prescott will also inspect all work and make all necessary approved field modifications. He will also be responsible for monitoring field progress, initial review of subcontractor submittals and other correspondence. Mr. Prescott (or his designee) will also be the Site Health & Safety Officer and Resident Inspector responsible for implementing and enforcing the Site Health and Safety Plan during all field activities and will also serve as the Site QA Manager. As the Site QA Manager, he will be responsible for the day-to-day QA during field activities ensuring that all post-excavation samples are obtained in accordance with UMC's SOPs, and

that labels and Chain of Custody forms are completed properly prior to shipment to the laboratory for analysis.

Project geologists and other staff members are not included on the organizational chart.

During the investigation phase (sample collection) there may be a need for a Site Supervisor. If a Site Supervisor is not needed, one person from each of the two-person sampling crews will be designated as the field team leader (FTL) and responsible for managing their work production.

Mike Rossi of Stone Environmental, Inc. of Montpelier, Vermont will be the laboratory manager for the mobile laboratory.

Elizabeth Dickinson of Trillium, Inc. of Coatesville, Pennsylvania will be the Project Manager and Principal Validator for the data validation of the analyzed data.

Peter and Marjorie Pratt of Pratt and Pratt Archeological Consultants, Inc. of Cazenovia, New York will be the Project Directors for the Phase 1 Cultural Resource Survey required by the Statement of Work.

Qualifications for other subcontractors to be used, including a surveyor (if required), a drill subcontractor (if required), a dredging/pumping subcontractor, and a public relations firm, will be submitted at a later date.

2.3 SITE MANAGEMENT

2.3.1 Site Office

As described below, UMC will make the necessary arrangements to have the site office located inside the perimeter fencing that was constructed located south of Gulf Road during the NYSDEC RI phase of the Project. The office trailer will be used to:

- Maintain records on-site;
- Contain communication equipment i.e. phone, fax, computer, etc.;
- Store the Health and Safety and sampling equipment;
- Provide security of the work area; and
- Provide a location for site meetings.

The site office will be mobilized to the site when field sampling and remediation activities are occurring. Local utilities and trash haulers will be contacted prior to establishment of the site office to ensure that service begins by the time field activities commence.

2.3.2 Equipment and Material Staging Area

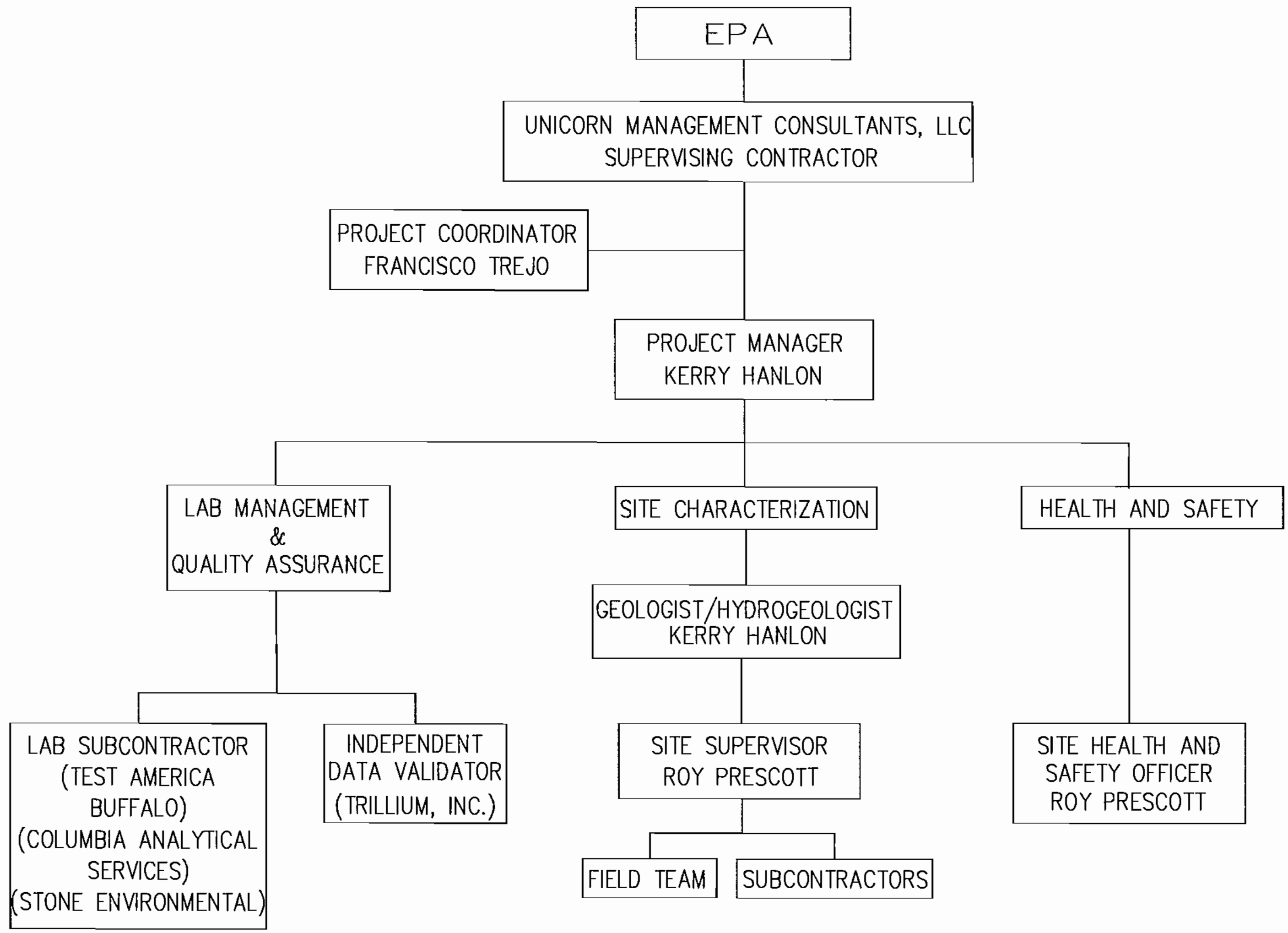
Equipment and material required for field activity will be stored within the office trailer or directly outside of the trailer, within the fenced-in area. Routine maintenance and repairs (when possible) will be conducted in this area. The trailer area will be cleaned regularly and kept free of maintenance waste and debris at all times. The site trailer area will be returned to its original condition after the trailer(s) are removed.

2.3.3 Recordkeeping

All original documents will be stored in UMC's corporate offices located in Danbury, CT. Correspondence to EPA, NYSDEC, and other agencies, manifests, cost estimates and schedules, monthly schedule updates, monthly reports and the SA, SOW, HASCP, QAPP are examples of the documents to be kept in the office. The UMC Project Manager will designate a central location to store these documents so they will be accessible to all appropriate LVRR Remedial Design Professional employees. Field logs and other documents (e.g., letters and photographs) will be maintained in the field office so that work activities can be monitored and documented. Copies of field logs and other documents will be sent to the Danbury Office at a minimum of once a week.

2.4 PUBLIC RELATIONS

The Project Manager will be responsible for coordinating communication with the public (i.e., public meetings or mailings); this will generally be done in consultation with EPA and NYSDEC. During field activities, the Site Supervisor will be responsible for all on-site interactions with EPA and NYSDEC and any other public or non-LVRR Remedial Design Professional entities. The Site Supervisor will be responsible for notifying the Project Manager of the content of these contacts.



REVISIONS				
NO.	DATE	PROJECT	LEHIGH VALLEY RAILROAD SUPERFUND SITE LEROY, NEW YORK	
5	7/09	DRAWING	ORGANIZATIONAL CHART	

Unicorn Management Consultants, LLC
52 FEDERAL ROAD
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PROJECT # 2032
FILENAME: OrgChart_2032
SCALE: NTS
DATE: 7/29/09
BY: GPK
CK: RP
FIGURE # 2-1

3 REQUIREMENTS FOR PRE-DESIGN STUDIES

UMC has requested that EPA provide any previously gathered data (e.g., core logs, Down-hole geophysical logs, surface geophysical logs, etc.) from NYSDEC or EPA during the previous investigations. UMC will review that information and collect additional data in support of a Remedial Design. The tasks were developed after review of the information UMC has available and in accordance with the Statement of Work.

3.1 SOIL CONTAMINATION

UMC has proposed to collect soil samples to better define the horizontal, vertical, and spatial boundaries of the VOC contamination area (Source Area) that exceed the cleanup objective. The proposed supplemental sampling program will follow the protocols detailed below. Pre-sampling inspection will be performed and photographs will be taken to determine if activities (since the original samples were collected in 1998 as shown on Figure 3-1) have occurred that would alter the location of the TCE contaminated soil.

3.1.1 Proposed Unbiased Samples

As shown on Figure 3-1, UMC proposes to collect soil samples on a 50 foot by 50 foot grid. Starting from the middle of the suspected spill area (grid node E5), soil borings will be advanced to bedrock at each grid node and soil samples will be continuously collected in two-foot intervals. The soil boring activities will extend outward in each direction from E5. The soil samples will be screened for VOCs using a photoionization detector (PID). The PID will be calibrated according to the equipment manufacturer's procedure using a 10 parts per million by volume (ppmv) TCE calibration gas.

Samples with PID readings above background will either (1) be analyzed by the mobile laboratory or (2) presumed TCE contaminated and designation for remediation. Special attention will be made for samples collected at the soil/bedrock interface to determine if DNAPL is potentially present at the interface and whether potential decontamination of the bedrock surface is required.

Soil samples with no or minimal PID readings will be analyzed by the mobile laboratory for confirmation. The initial PID screening level for samples to be analyzed in the laboratory will be 3.5 ppmv. The PID screening level will be adjusted in the field based on mobile laboratory TCE results. UMC will extend the sampling grid horizontally in all directions until the limits of the TCE contamination (in excess of 7.0 ppm) have been delineated.

As discussed in the QAPP, both the horizontal and vertical limits of excavation will be defined by samples analyzed by the mobile laboratory.

3.1.2 Proposed Biased Samples

After the initial walk through of the area, UMC will include additional boring locations between grid nodes in locations where the TCE liquid may have flowed on the ground surface (i.e., small swales or depressions).

3.1.3 Data Summary Report

At the conclusion of the sampling effort, a Data Summary Report for the overburden soil will be prepared and submitted to EPA. The Data Summary Report for the overburden soil will provide which technology is potentially the most appropriate and propose the pilot study required (if necessary) to design the system. Depending on the results of the supplemental investigation, UMC will evaluate the technologies presented in Section 4.3 as remedial alternatives for remediation of the TCE contaminated soil.

3.2 BEDROCK (VADOSE ZONE) CONTAMINATION

3.2.1 Purpose and Approach

The purpose of the Pre-RD Investigation of bedrock in the NAPL/Spill Zone is to:

- Collect information needed to help determine whether there are conditions at the Site, such as the presence of a source area of dense non-aqueous phase liquid below the vadose zone, which would limit or undermine the effectiveness of BVE in the NAPL/Spill Zone; and
- Evaluate existing information and collect additional information on the bedrock fracture network; install borings within the NAPL/Spill Zone and conduct down-hole tests in order to determine any appropriate zone to target for BVE.

The source area and groundwater were previously made separate Operable Units (OUs). An RI/FS Workplan for the groundwater OU was previously prepared and approved by EPA. The bedrock source investigation is designed to complement the approved RI/FS Workplan in order to gain a better understanding of the site as a whole. Some of the bedrock source investigation work will provide data used to support the groundwater RI/FS and some of the groundwater RI/FS work will provide data used to support the bedrock source investigation.

3.2.2 Proposed Bedrock Investigation Tasks

Although some iteration of specific work items may be required, the tasks below are presented in general chronological order.

3.2.2.1 Prepare a Geo-Referenced Base Map and GIS Database

This task is being done as part of the Groundwater RI/FS. A photogammetric survey of the site with a two-foot contour interval will be prepared showing roads, structures and other geographical features in the study area. The photogammetric survey data will be entered into a Geographic Information System (GIS) Database and will be used as the base map for all future work at the site. Existing data will be entered into the GIS Database as will all new data generated at the site.

3.2.2.2 Identify Existing Wells and Borings

Monitoring wells and other borings, e.g., vapor extraction wells, installed in and immediately down-gradient (east) of the source area (shown on Figure 3-2) will be identified using visible identification marks at the well head, existing site maps and available well/boring logs.

The location of all wells found in the field will be determined with a Global Positioning System (GPS). The total well depth and depth to water will be determined and used to help identify the wells and determine their usability. All existing wells found and positively identified will be permanently marked at the well head with their original identifier.

3.2.2.3 Install Staff Gauges

The RI/FS Workplan requires installation of approximately ten (10) staff gauges. In addition to these ten (10) staff gauges, one (1) additional staff gauge will be installed in each of the following locations: the abandoned quarry north of the spill zone; the intermittent pond east of the spill zone between the former LVRR main line and Gulf Road; and in the Mud Creek channel south of the spill zone. The approximate locations of the three additional staff gauges are shown on Figure 3-2.

3.2.2.4 Water Elevation Measurements

Water elevation measurements will be taken from the three staff gauges and usable borings/wells in the source area. The water elevation measurements will be taken within a one-day period without precipitation. The water elevation measurement will coincide with the water elevation measurements to be taken from the 58 existing monitoring wells and 10 staff gauges required during the site reconnaissance task in the RI/FS Workplan. Measurements will be collected in accordance with the appropriate Standard Operating Procedures (SOPs) which are included in the QAPP.

3.2.2.5 DNAPL Inspection of Existing Wells

Usable wells in the source area and immediately east of the source area will be inspected for the presence of Dense Non-Aqueous Phase Liquid (DNAPL) with an electronic interface probe in accordance with the appropriate SOPs which are included in the QAPP. If significant sedimentation has occurred in the well, the presence of DNAPL may be checked with a hydrophobic dye swab.

UMC anticipates that the following wells (shown on Figure 3-2) will be checked for DNAPL:

- Source zone monitoring wells (DC-1, DC-5 and DC-15 series)
- BVE pilot test wells EW-1, EW-3, EW-7, EW-8 and EW-10;
- Monitoring Wells DC-3, DC-6, DC-16,and DC-17 series wells located east of the source zone; and
- The out-of-service residential well at corner of Neid and Gulf Roads.

3.2.2.6 Borehole Geophysics in Existing Wells

Borehole Geophysics will be conducted on usable wells in the source area and immediately east of the source area. UMC anticipates that the following geophysical methods will be used:

- Optical televiewer;
- Caliper;
- Temperature;
- Gamma; and
- Spontaneous potential.

UMC anticipates that down-hole geophysics will be performed in the following wells:

- Source zone monitoring wells (DC-1, DC-5 and DC-15 series)
- BVE pilot test wells EW-1, EW-3, EW-7, EW-8 and EW-10;
- Monitoring Wells DC-3, DC-6, DC-16,and DC-17 series wells located east of the source zone; and
- The out-of-service residential well at corner of Neid and Gulf Roads

3.2.2.7 Groundwater Sampling Round

The RI/FS Workplan requires sampling of the existing 58 monitoring wells and approximately 30 private wells during the site reconnaissance task. Data from that sampling event will be used to assist in deciding the location of additional bedrock investigation corings, borings and wells.

3.2.2.8 Installation of FW-19 Well Cluster

The RI/FS Workplan requires installation of a pumping test well (designated "FW-19") and four piezometers (collectively designated "cluster FW-19") as part of the Hydrogeological Assessment Task. The approximate location of cluster FW-19 is shown on Figure 3-2. Further, the RI/FS Workplan requires down-hole geophysical and packer testing of FW-19.

The following work will be done at the FW-19 cluster in addition to the work required by the RI/FS Workplan:

- Advance one additional boring to the same depth as FW-19;
- Conduct down-hole geophysics in all cluster FW-19 wells;
- Collect continuous conductivity profiles in all cluster FW-19 wells using the Flexible Liner Underground Technologies ("FLUTe") Liner technology, and
- Install a multi-zone sampling system in the additional deep boring.

Continuous hydraulic conductivity profiling using the FLUTe Liner technology has been successfully used at fractured bedrock sites. Technical information for the FLUTe Liner is provided in Appendix A of this RD Work Plan.

Either of two multi-zone monitoring/sampling systems will be installed in the additional deep boring, the FLUTe System or the Waterloo System. Both have been successfully used at fractured bedrock sites. Technical information for the FLUTe and Waterloo systems is provided in Appendices A and B of this RD Work Plan respectively.

3.2.2.9 Installation of Boring Transect West of Church Road

Based on review of the data generated in the preceding tasks, a transect location west of Church Road will be selected. The transect will comprise a series of five (5) six-inch diameter borings completed to a depth of approximately 200 feet. The borings will be oriented perpendicular to the long axis of the plume. The approximate expected location of the transect is shown on Figure 3-2. The final location of the transect and individual borings will be determined based on review of historical data, data generated from the preceding tasks, and field conditions.

The following will be done in each boring:

- Deploy FLUTe NAPL Ribbon sampler to determine presence of NAPL;
- Conduct down-hole geophysics including optical televiewer, standard logs (caliper, temperature, gamma, spontaneous potential) and bore-hole flow meter measurement under ambient and pumping conditions;
- Perform packer testing on select zones and collect samples for on-site laboratory analysis for TCE;
- Collect continuous hydraulic conductivity profiles using FLUTe Liner technology; and
- Install multi-zone sampling devices.

3.2.2.10 Installation of Core Hole at Down-Gradient Edge of Source Zone

Based on review of the data generated in the preceding tasks, a location will be selected for an up to 200-foot deep core hole at the down-gradient edge of the source zone. The core hole will be advance using the triple tube HQ coring method. Technical information on this coring method is provided in Appendix C of this Work Plan.

The following will be done as part of the coring activities:

- Visual logging of cores
- Analysis of bedrock using the Parker Method to crush, extract and analyze rock samples;
- Deploy FLUTe NAPL Ribbon sampler to determine presence of NAPL;
- Conduct down-hole geophysics including optical televiewer, standard logs (caliper, temperature, gamma, spontaneous potential) and bore-hole flow meter measurement under ambient and pumping conditions;
- Perform packer testing on select zones and collect samples for on-site laboratory analysis for TCE;
- Collect continuous conductivity profiles using FLUTe Liner technology; and
- Install multi-zone sampling devices.

The Parker Method is a proprietary technique developed at the University of Waterloo for extracting COCs from rock matrices with minimal loss. The SOP for the Parker Method will be provided in the QAPP.

3.2.2.11 Installation of Core Hole in Spill Area

Based on review of the data generated in the preceding tasks, a location will be selected for an up to 65-foot deep core hole in the unsaturated zone in the spill area. The core hole will be advanced using the triple tube HQ coring method.

The following will be done as part of the coring activities:

- Visual logging of cores;
- Analysis of bedrock using the Parker method to crush, extract and analyze rock samples;
- Deploy FLUTe NAPL Ribbon sampler to determine presence of NAPL;
- Conduct down-hole geophysics including optical televiewer, standard logs (caliper, temperature, gamma, spontaneous potential).

3.2.3 Survey

All staff gauges boring, coring and wells installed as part of the bedrock investigation will be surveyed by a licensed New York State Surveyor. Well locations will be surveyed to the nearest 1.0 foot, and ground surface elevation and inner casing elevation will be surveyed to the nearest 0.01 foot.

3.2.4 Investigation Derived Waste

The RI/FS Workplan specifies the handling of Investigation Derived Waste (IDW). The volume of IDW generated during bedrock investigation will be much less than that generated during implementation of the RI/FS Workplan. All IDW generated during the bedrock investigation will be handled in a similar manner to the IDW waste generated during implementation of the RI/FS Workplan.

Drill cuttings will be containerized on-site. Based on analytical results, these materials will either be treated on-site or disposed of by a licensed IDW subcontractor. One cutting sample will be collected from each boring/coring location during drilling activities. These samples will be analyzed for Low Concentration VOCs and cyanide. If sample data indicates levels to be at or below the Remedial Action Objectives stated in Table 2 of the ROD (TCE<7.0 ppm, total DCE<3.0 ppm and CN<15 ppm), the containerized waste will be discharged to ground surface at the Spill Site.

Water generated during drilling and sampling will be containerized at the well head and then transferred to a frac tank staged at the Spill Site. Water not meeting the Remedial Action Objective of less than 5 ppb TCE will be treated by the on-site GAC unit prior to discharge to the ground surface in accordance with the RI/FS Workplan.

Decontamination fluids will be containerized and characterized for on-site treatment or off-site disposal.

3.2.5 Data Summary Report

At the conclusion of the bedrock investigation activities, a Data Summary Report for the contaminated bedrock will be prepared and submitted to EPA. All geological, hydrogeological, geophysical, hydrological, and chemical data generated during the bedrock investigation will be presented.

The data will be evaluated to determine;

- the presence and relative mass of contamination below the water table;
- the presence of DNAPL below the water table;
- the presence, distribution and relative mass of contamination in the rock matrix (primary porosity) below the water table; and
- the presence, distribution and relative mass of contamination in the rock matrix (primary porosity) above the water table;

The evaluated data will be used to determine if the BVE is practicable for removing the source zone TCE mass, and if so, what would be the optimum design criteria for effective removal.

3.3 WETLAND DELINEATION SURVEY

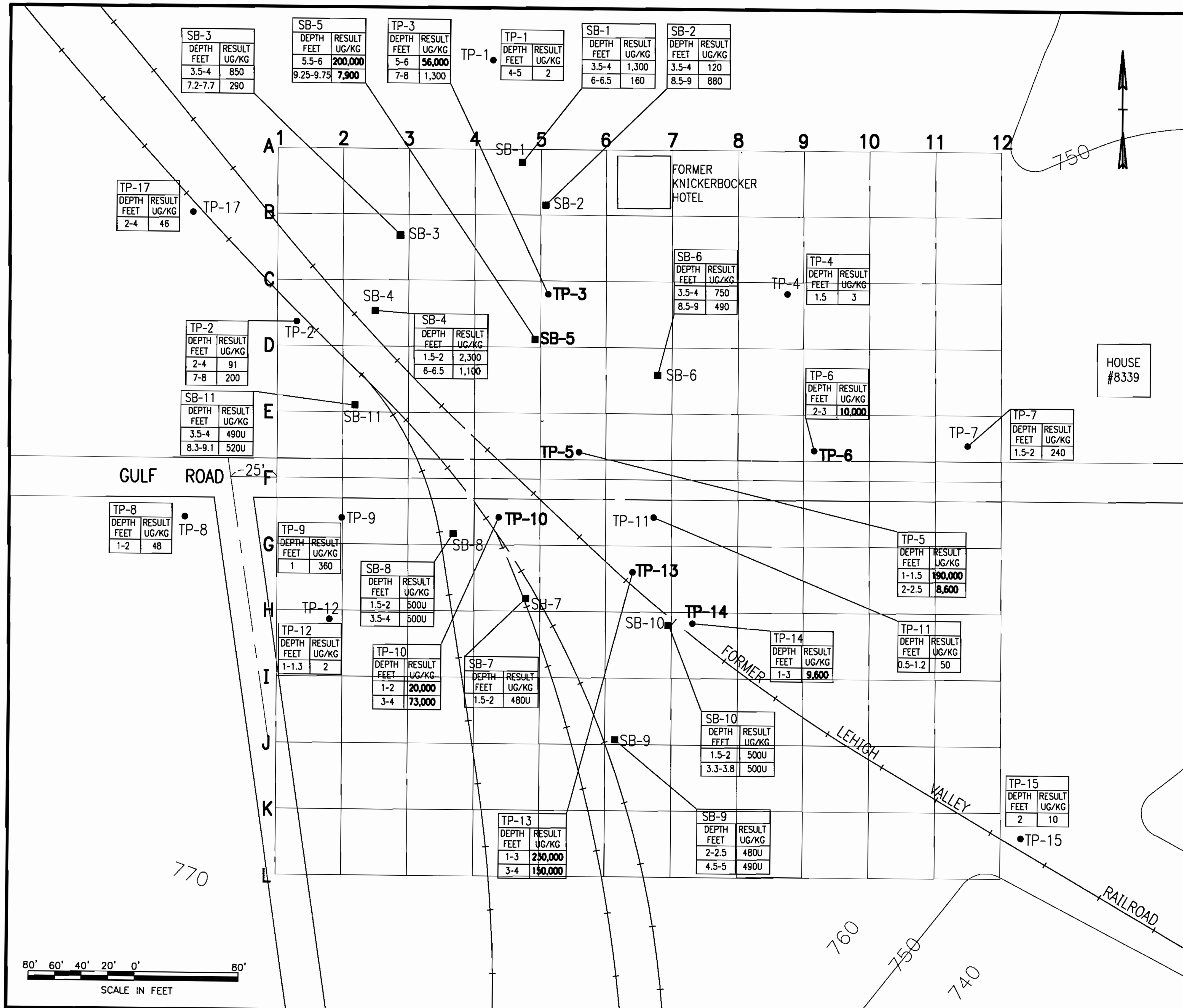
UMC will prepare and implement a Wetland Delineation Survey (in accordance with the routine determination method of the U.S. Army Corps of Engineers 1987 Wetland Delineation Manual) to determine existence of wetland areas within areas potentially impacted by the Work. If wetland areas exist within potentially impacted areas, UMC will prepare a Wetland Mitigation Plan to determine possible measures to mitigate wetland loss and include it findings in the Remedial Design.

3.4 PHASE 1 CULTURAL RESOURCE SURVEY

UMC will prepare a complete Phase 1 Cultural Resources Survey report for the NAPL/Spill Zone. This report will include Phases 1A and 1B and shall be in compliance with the National Historic Preservation Act, 16 U.S.C. § 470. This report will be a supplement to the Phase 1A (January 25, 1999) and 1B (July 14, 1999) and as supplemented on August 6, 2000 when the waterline was expanded. UMC will retain the services of Peter and Marjorie Pratt of Pratt and Pratt Archeological Consultants, Inc. of Cazenovia, New York to perform the survey and prepare the supplement report.

3.5 EVALUATION OF THE 100-YEAR AND 500-YEAR FLOOD PLAINS

UMC will obtain and evaluate the Federal Emergency Management Agency (FEMA) Flood Plain maps for this area. The Data Summary Reports will provide the conclusion of that evaluation and the Remedial Design will take into consideration the necessary precautions if the proposed remediation area is within the 100-year and/or 500-year floodplains.



NOTES:

RESULTS ARE SOIL CONCENTRATIONS OF TRICHLOROETHYLENE (TCE)

DEPTHS SPECIFIED ARE FEET BELOW EXISTING GRADE LEVEL

- ● TP# - TEST PIT LOCATION/SAMPLES COLLECTED BY RUST ENVIRONMENTAL AND INFRASTRUCTURE OF NEW YORK DURING REMEDIAL INVESTIGATION IN DECEMBER 1992.
- ■ SB# - SOIL BORING LOCATION/SAMPLE COLLECTED BY IT ENGINEERING OF NEW YORK DURING THE EX-SITU SOIL VAPOR EXTRACTION PILOT STUDY IN JULY 1998.

LOCATION WHERE PREVIOUS SAMPLES INDICATE THAT TCE CONCENTRATIONS ARE IN EXCESS OF THE 7.0 PPM CLEANUP STANDARD.

BOLD SAMPLE CONCENTRATION EXCEEDING 7.0ppm CLEANUP STANDARD AS PER THE ROD

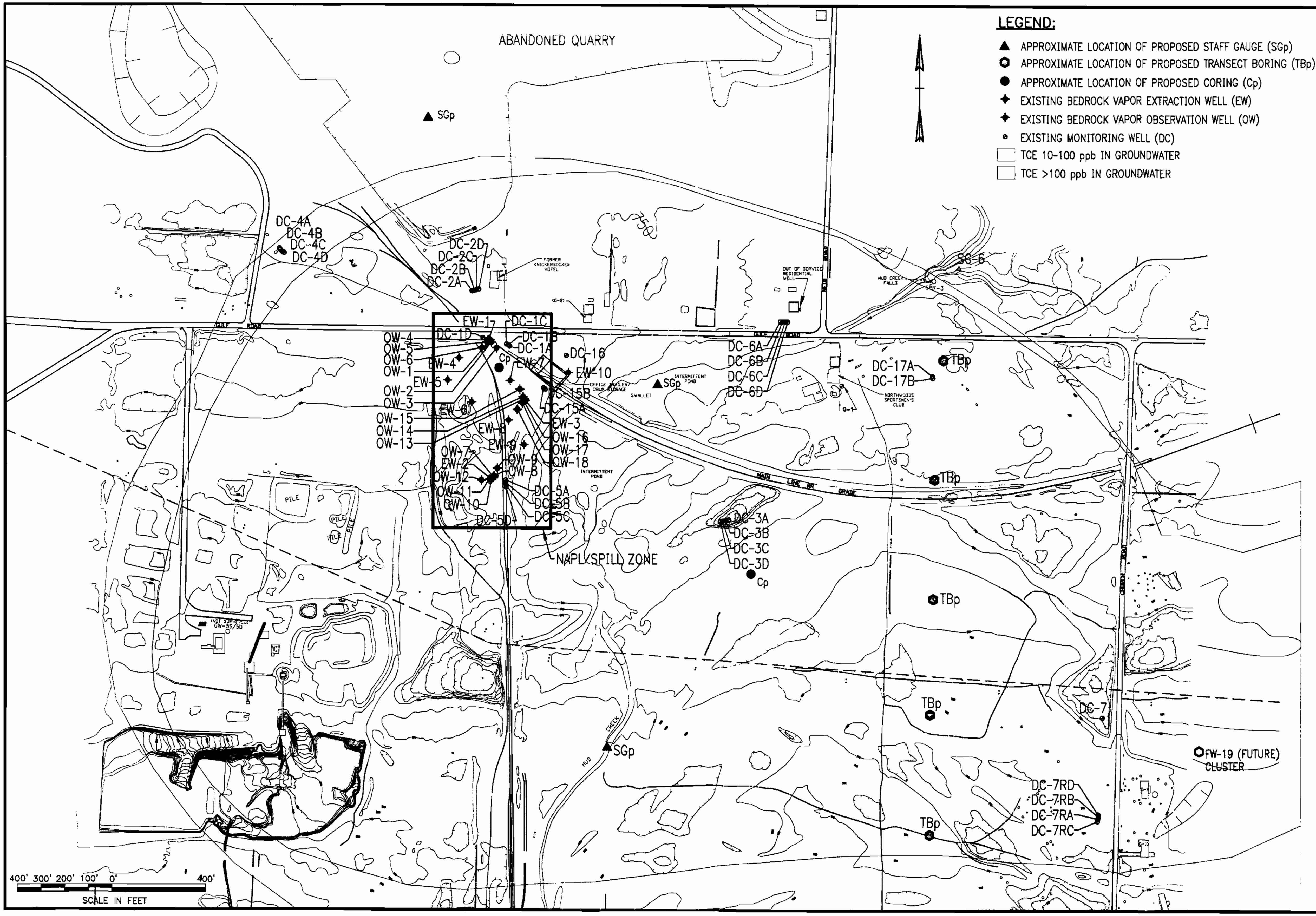
REVISION NO.	
NO.	DATE

PROJECT: LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LE ROY, NEW YORK

DRAWING: PROPOSED OVERBURDEN SOIL SAMPLING GRID

Unicorn Management Consultants, LLC
52 FEDERAL ROAD
DANBURY, CT
(203) 205-9000

PROJECT # 2032-100
FILENAME: USCS FINAL
SCALE: 1"=80' DATE: 5/9/07
BY: AD CK:
FIGURE # 3-1



REVISION NO.	
NO.	DATE

LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE

LE ROY, NEW YORK

PROJECT

PROPOSED BEDROCK INVESTIGATION LOCATIONS

DRAWING

Unicorn Management Consultants, LLC
52 FEDERAL ROAD
DANBURY, CT
(203) 205-9000

PROJECT # 2032-100
FILENAME: 2032100A
SCALE: 1" =400'
DATE: 6/1/07
BY: AD
CK:
FIGURE # 3-2

4 DESIGN CRITERIA

The anticipated clean-up procedures and activities to be incorporated into the design for the excavation, removal, and treatment of contaminated soil at the source area will include the items listed below.

4.1 GENERAL ASSUMPTIONS

- The requirements of the SA will be adhered to and incorporated into the Contract documents.
- OSHA training will be a requirement for all personnel working on-site. Names of key personnel and their qualifications are to be provided.
- Available information regarding previous sampling records will be reviewed and incorporated into Contract Documents.
- Data collected during pre-design activities will be evaluated and an acceptable methodology for removal of the estimated amount of material will be established. This information is also to be incorporated into Contract Documents.
- Applicable local, Federal, and State rules and regulations regarding the undertaking of remedial activities in sensitive areas will be followed. Permit requirements are to be adhered to during remediation activities.
- Appropriate notifications prior to the commencement of any remedial work will be incorporated into the remedial design requirements.
- All unearthed material will be transported to a storage area agreeable to EPA, NYSDEC and LVRR for proper storage and handling.
- Public health and safety issues are prerequisites to successful project completion.
- The Site Health and Safety Plan is to be adhered to and the requirements strictly enforced.
- Access requirements and property ownership issues will be considered and appropriate permissions in place prior to the commencement of work.
- Contingency planning for unexpected situations will be incorporated into the Contract Documents.
- Control of traffic and access to work areas during excavation and backfilling activities, including coordination with local police and other authorities, will be required.
- Reduction and control of fugitive particulate emissions during excavation, transportation, and other material handling operations, will be strictly enforced.
- The requirements of the Contract Documents are to include liability and environmental insurance and bonding requirements.

- UMC will require information from potential subcontractors regarding successful projects and will request references.
- Contract Documents will follow standard engineering requirements and the Remedial Work Plan is to be adhered to during work activities.
- Safety and progress meetings between contract administration staff, contractors, NYSDEC, and EPA are required on a periodic basis.
- Erosion and sediment control requirements are to be strict and enforceable during remedial activities.
- As-built drawings and information will be provided at the completion of remedial operations.

4.2 OVERBURDEN SOIL REMEDIAL DESIGN PLAN

The Overburden soil remedial design will include documents depicting areas to be excavated, estimated volumes of soil for removal, information concerning methods to be used to remove the contaminated material, soil preparation, soil placement, vapor extraction piping sizing and location, blower sizing, treatment design, and anticipated scheduling. Elements addressed in the design will include, but may not be limited to, the following:

Site access, public communication and cooperation;

Areas to be excavated;

Excavation methods;

Proposed excavation depths;

Material handling and placement procedures;

Soil Preparation (mechanical sorting);

Vapor Extraction System Requirements;

Emissions Treatment Requirements;

Performance Requirements;

Site cleanup and restoration; and

Procedures to verify project closure.

Following soil sample collection as described in subsections 3.1.1 and 3.1.2, UMC will provide EPA with a Remedial Design Report that will propose which areas will require soil removal and at what depths, what areas will require the bedrock to be exposed and cleaned, and which areas are designated for soil consolidation and where the vapor extraction system will be installed.

4.2.1 Excavation Efforts

UMC will utilize data from the sampling effort described in subsection 3.1 to predetermine the areas and depths of excavation required prior to remediation activities.

These proposed areas and corresponding depths will be presented in the RD Report, which will be provided to EPA for review and approval.

4.3 VADOSE ZONE BEDROCK

As stated in Section V. C. of the SOW, a BVE Data Summary Report is only required, which will contain the information collected in order to determine whether there are conditions at the Site, such as the presence of a source area of dense non-aqueous phase liquid below the vadose zone, which would limit or undermine the effectiveness of BVE in the NAPL/Spill Zone. A Remedial Design is not required for the Vadose Zone Bedrock.

5 TENTATIVE TREATMENT SCHEMES

5.1 SOIL CONTAMINATION

5.1.1 Ex-situ and In-situ Vapor Extraction Technology

An ex-situ soil vapor extraction pilot test was performed by IT of New York for the NYSDEC in 1999. In summary, approximately 50 cubic feet of TCE contaminated soil was excavated and placed in a pile with horizontal extraction and monitoring pipes placed one (1) foot from the base of the pile. Though initial samples were analyzed, post-study samples were not. Also, during the testing procedures, no vacuum influence was observed as close as one foot away from the extraction pipe. IT tried to modify the extraction pile by placing an impervious cover over it, but to no avail. With the current information available, UMC can not design an extraction system.

Since the pilot test performed provided no usable data to design as SVE system, another pilot study would be necessary if this alternative is utilized. As part of the pre-design efforts, UMC is considering an ex-situ and in-situ vapor extraction pilot study to provide data required to design a vapor extraction system.

Following the supplemental soil investigation efforts proposed in the QAPP, UMC will select the appropriate location(s) to perform the pilot study. UMC intent is to excavate and remove the TCE contaminated soil from the shallow (shallow depth to bedrock) areas, mechanical separate the larger particles (large rocks and debris) and place the screened material in areas that have deeper TCE contaminated soil that does not extend to the bedrock. The areas where TCE contamination extends to the bedrock interface will require excavation to bedrock for visual observation and cleaning, therefore in-situ vapor extraction will not be performed in those areas. After the soil is placed in these areas, vapor extraction and monitoring wells will be installed and the areas will be covered by an impervious (polyethylene) cover and tested accordingly.

5.1.2 Other Technologies Considered

Depending on the results of the Pre-RD Investigation, UMC may consider other technologies to remediate the contaminated soil. Other remedial alternatives to be considered are (among others), Low Thermal Desorption and Disposal to a hazardous waste landfill.

Low Thermal Desorption has been proven effective and a pilot study is not required to prepare a remedial design. If this technology is the most appropriate, a field test will be performed after mobilization to determine the most effective feed rate and temperature. All treated soil that contains TCE in excess of the performance standard (7 mg/kg – TCE) will be sent through the process again.

Disposal to a hazardous waste landfill is also effective and will not require a pilot study or field test since no treatment will be performed on-site.

5.2 VADOSE ZONE BEDROCK

As stated in Section V. C. of the SOW, only a BVE Data Summary Report is required, therefore no treatment schemes are proposed for the Vadose Zone Bedrock.

6 QUALITY ASSURANCE PROJECT PLAN

On March 26, 2008, UMC submitted a revised Quality Assurance Project Plan (QAPP) to EPA that incorporates additional quality assurance requirements needed to implement the SOW. EPA approved the revised QAPP on March 31, 2008. By revising and replacing the previous QAPP (dated November 6, 2006), only one (1) QAPP will be used for this project, which will eliminate the potential confusion of having two (2) QAPPs.

7 HEALTH AND SAFETY CONTINGENCY PLAN

On March 26, 2008, UMC submitted a revised Health and Safety Plan (HASP) to EPA that incorporates additional health and safety requirements needed to implement the SOW. The EPA approved the revised HASP on March 31, 2008. By revising and replacing the previous HASP (dated November 6, 2006), only one (1) HASP will be used for this project, which will eliminate the potential confusion of having two (2) HASPs.

8 PROJECT SCHEDULE

The schedule for completing this RD Work Plan is based on two major assumptions described below. Figure 8-1 illustrates the anticipated project schedule based on these assumptions. A revised schedule will be issued upon receiving EPA approval of the Remedial Design Work Plan.

The major assumptions concerning the schedule for the implementation of this Remedial Design Work Plan are:

- This schedule includes an estimated number of days that EPA will need to review each plan. The schedule may increase or decrease depending on the required time for EPA to review each document.
- This schedule includes an assumed number of days to obtain the appropriate permissions from homeowners and businesses allowing us access to their property. The schedule may increase depending on the required time to obtain these Agreements.

Figure 8-1

Project Schedule
Lehigh Valley Railroad Derailment Superfund Site
Town of LeRoy, Genesee County, New York

ID	Task Name	Duration	Start	Finish
1	**Total Project (Progress Reports due 15th of each month)**	**2335 days**	**Fri 10/6/06**	**Mon 2/25/13**
2	Effective Date of Administrative Order of Consent	1 day	Fri 10/6/06	Fri 10/6/06
3	Selection of Project Coordinator	5 days	Mon 10/16/06	Fri 10/20/06
4	Submit Project Baseline Schedule	9 days	Sun 10/15/06	Mon 10/23/06
5	Selection of Supervising Contractor	6 days	Wed 11/1/06	Mon 11/6/06
6	Changing the Supervising Contractor	4 days	Mon 3/19/07	Thu 3/22/07
7	EPA Approval of Project Coor. and Sup. Cont.	148 days	Tue 11/7/06	Tue 4/3/07
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9	**Access Agreements**	**863 days**	**Sat 10/7/06**	**Sun 2/15/09**
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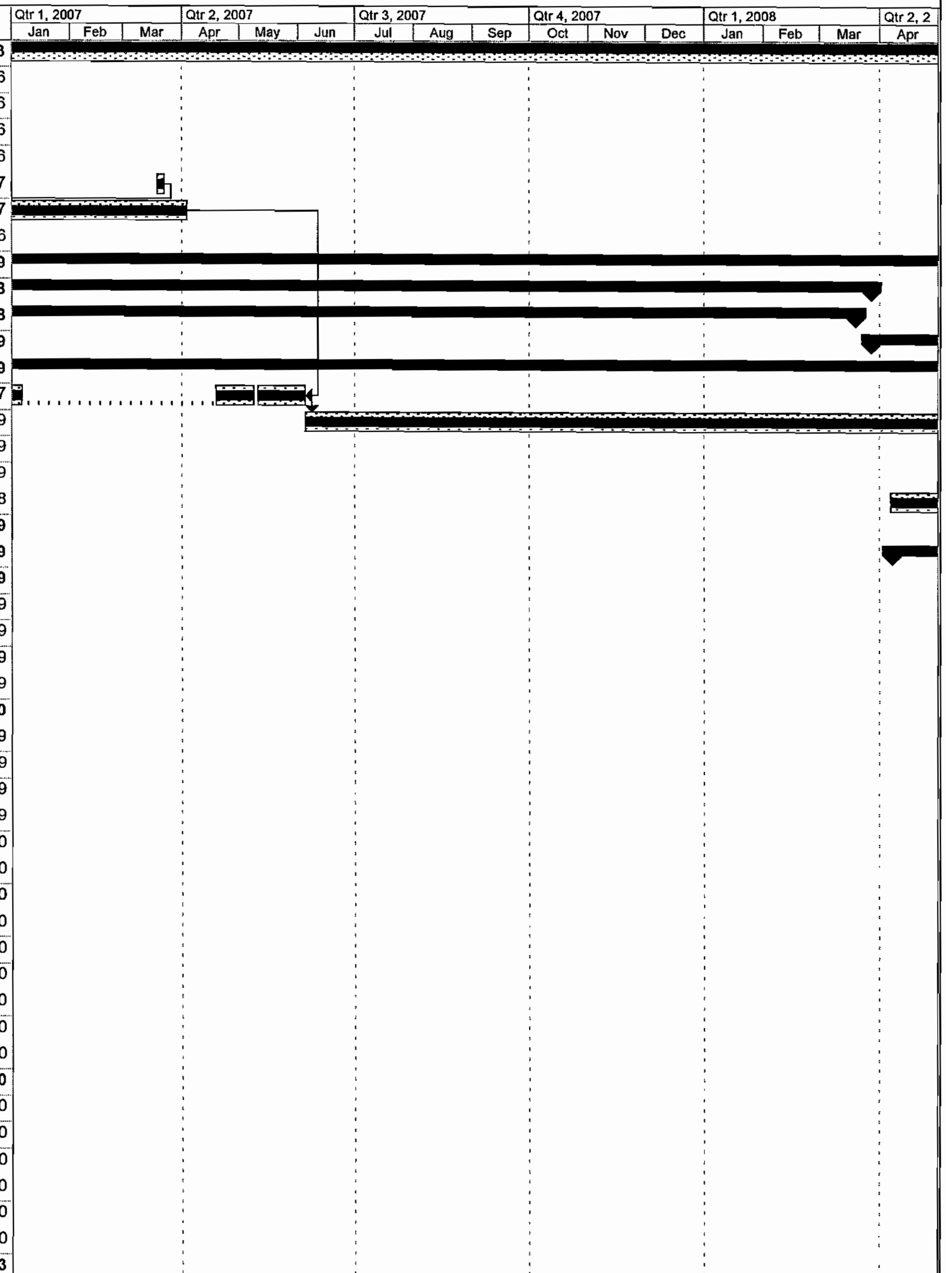

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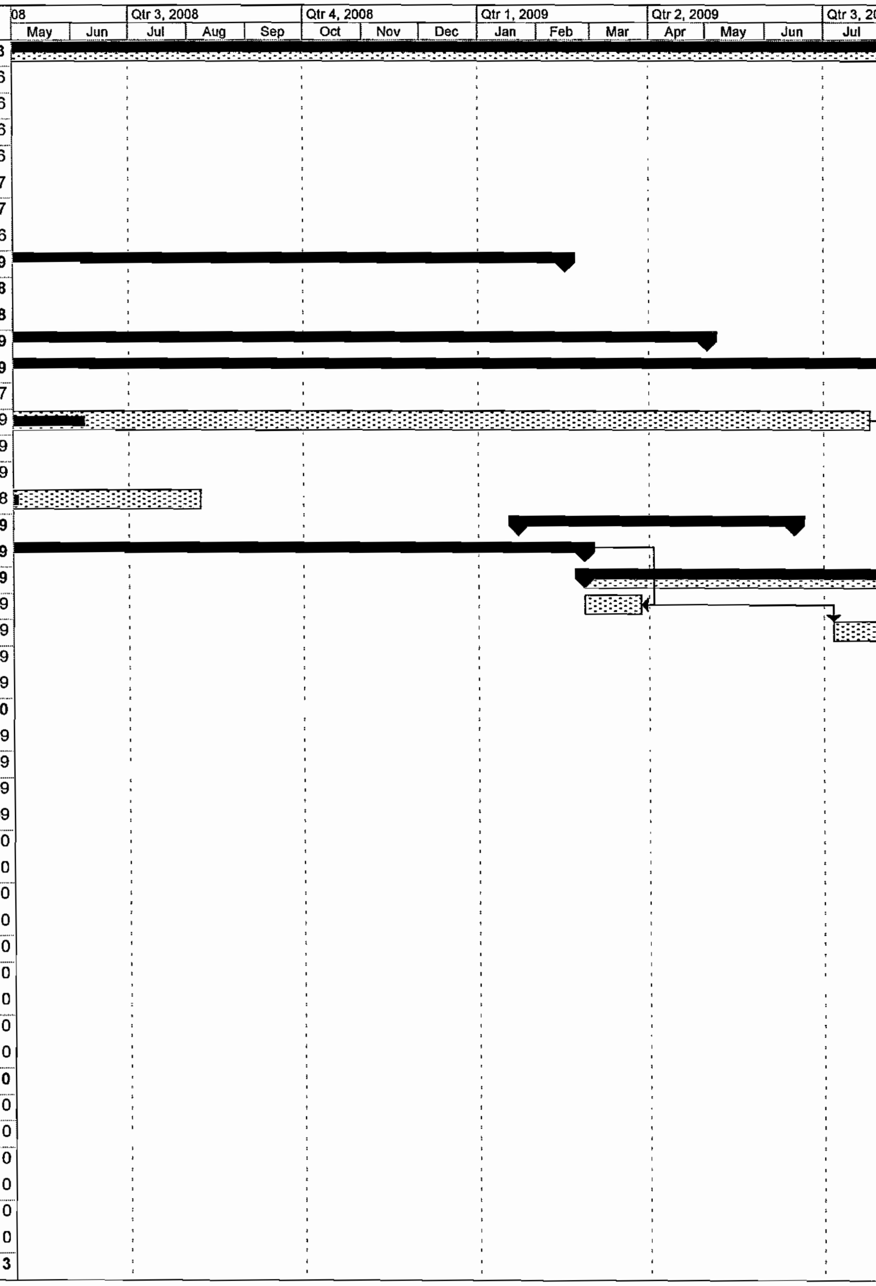

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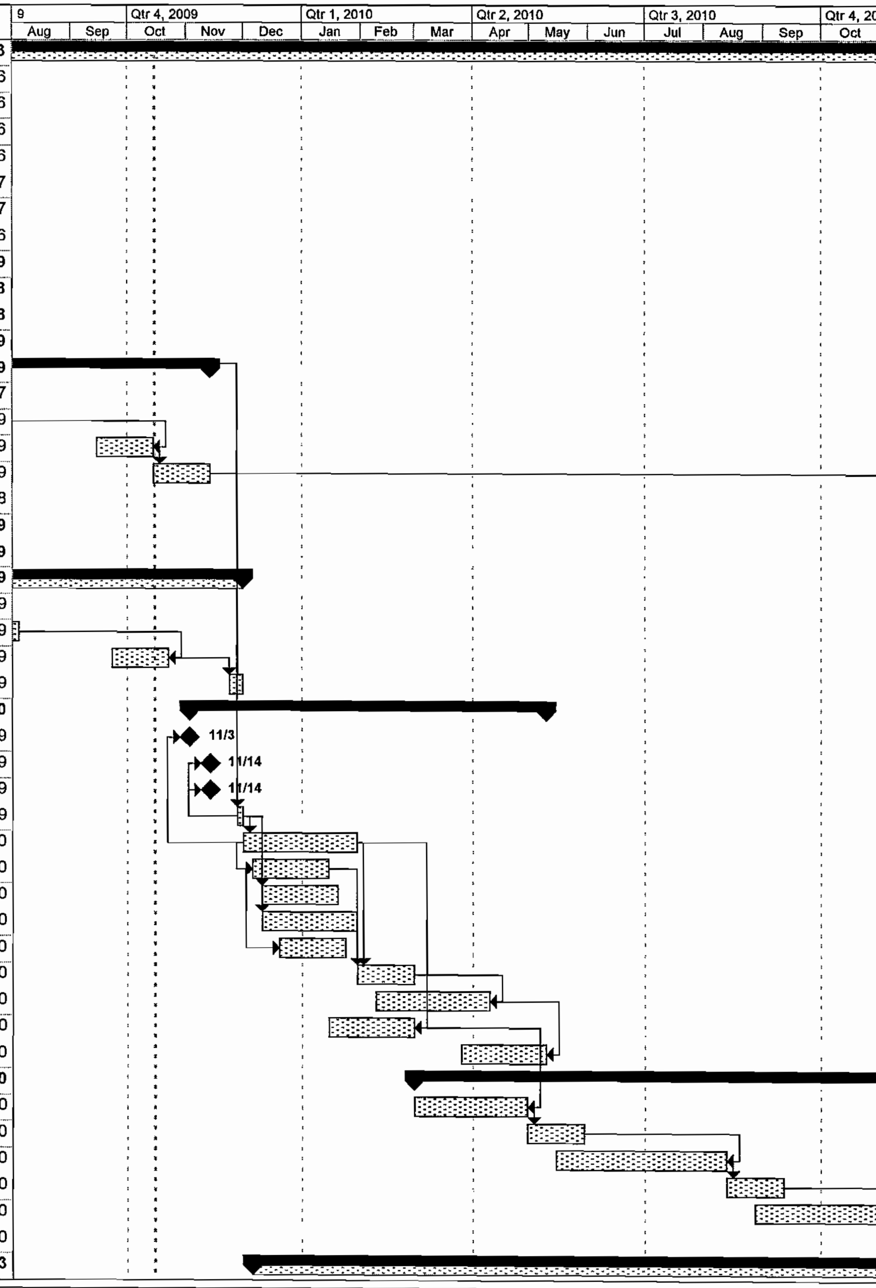

Project Schedule
Lehigh Valley Railroad Derailment Superfund Site
Town of LeRoy, Genesee County, New York

ID	Task Name	Duration	Start	Finish
1	**Total Project (Progress Reports due 15th of each month)**	**2335 days**	**Fri 10/6/06**	**Mon 2/25/13**
2	Effective Date of Administrative Order of Consent	1 day	Fri 10/6/06	Fri 10/6/06
3	Selection of Project Coordinator	5 days	Mon 10/16/06	Fri 10/20/06
4	Submit Project Baseline Schedule	9 days	Sun 10/15/06	Mon 10/23/06
5	Selection of Supervising Contractor	6 days	Wed 11/1/06	Mon 11/6/06
6	Changing the Supervising Contractor	4 days	Mon 3/19/07	Thu 3/22/07
7	EPA Approval of Project Coor. and Sup. Cont.	148 days	Tue 11/7/06	Tue 4/3/07
8	Establish and maintain financial security	0 days	Sun 11/19/06	Sun 11/19/06
9	**Access Agreements**	**863 days**	**Sat 10/7/06**	**Sun 2/15/09**
21	**QAPP and HASP - RI/FS**	**537 days**	**Sun 10/8/06**	**Thu 3/27/08**
27	**Draft Indoor Air Monitoring Plan (DIAMP) (RI/FS)**	**529 days**	**Sun 10/8/06**	**Wed 3/19/08**
36	**Implement IAMP**	**400 days**	**Fri 3/28/08**	**Fri 5/1/09**
48	**Remedial Design Work Plan - SOW**	**1124 days**	**Tue 10/17/06**	**Fri 11/13/09**
49	Prepare Remedial Design Work Plan	100 days	Tue 10/17/06	Mon 6/4/07
50	EPA review and comment of RD WP	781 days	Tue 6/5/07	Fri 7/24/09
51	Finalize Remedial Design Work Plan	30 days	Tue 9/15/09	Wed 10/14/09
52	EPA review and approval of RD WP	30 days	Thu 10/15/09	Fri 11/13/09
53	**EPA suspension of RI/FS Activities [Not Confirmed to Date]**	**123 days**	Mon 4/7/08	Thu 8/7/08
54	**Memo of Exposure Scenarios and Ass. (ESA Memo) (RI/FS)**	**145 days**	**Thu 1/22/09**	**Mon 6/15/09**
59	**Site Reconnaissance (3.01 - RI/FS)**	**324 days**	**Tue 4/8/08**	**Wed 2/25/09**
72	**Technical Memorandum (3.01.08 - RI/FS)**	**278 days**	**Thu 2/26/09**	**Mon 11/30/09**
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77	**Pre-RD Investigation - SOW**	**188 days**	**Tue 11/3/09**	**Sun 5/9/10**
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79	EPA notification of Field Activity	0 days	Sat 11/14/09	Sat 11/14/09
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84	Wetland Delineation Survey	40 days	Fri 12/11/09	Tue 1/19/10
85	Phase 1 Cultural Resources Survey	50 days	Fri 12/11/09	Fri 1/29/10
86	Down hole Geophysics	35 days	Sun 12/20/09	Sat 1/23/10
87	Sample Analysis	30 days	Sat 1/30/10	Sun 2/28/10
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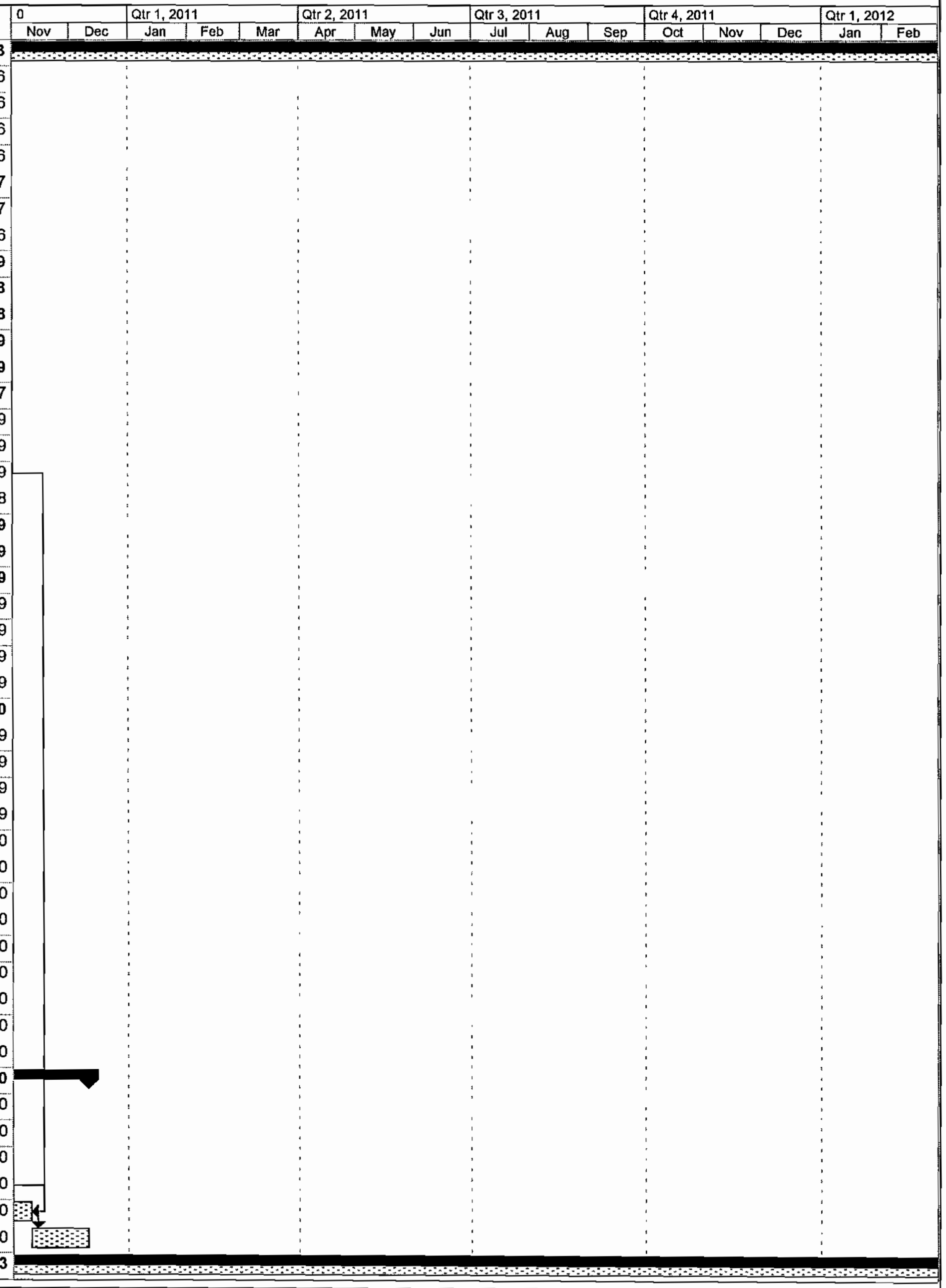

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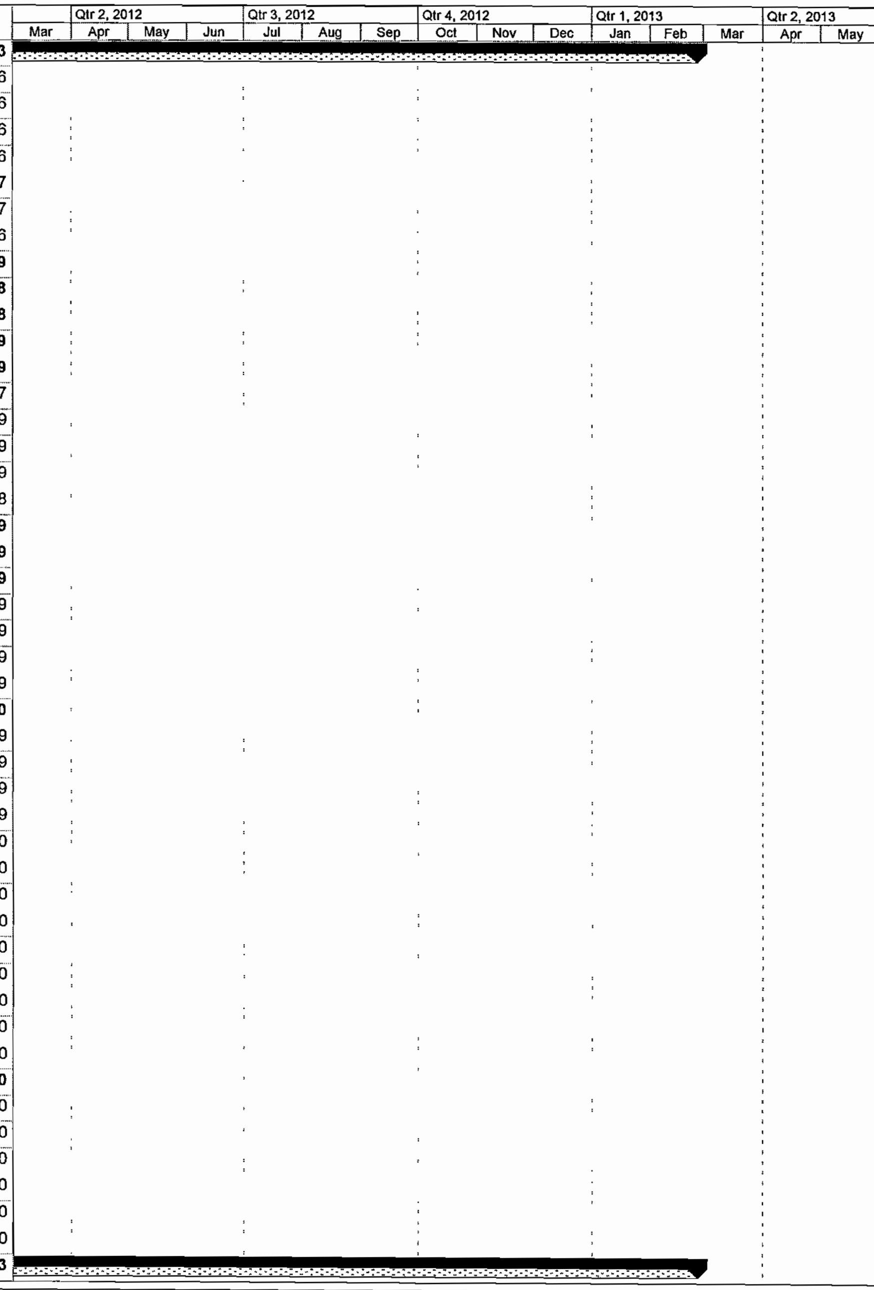

APPENDIX A

TECHNICAL INFORMATION FOR THE FLEXIBLE LINER UNDERGROUND TECHNOLOGIES ("FLUTe") LINER

6 Easy Street
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SYSTEMS

WATER FLUTe™

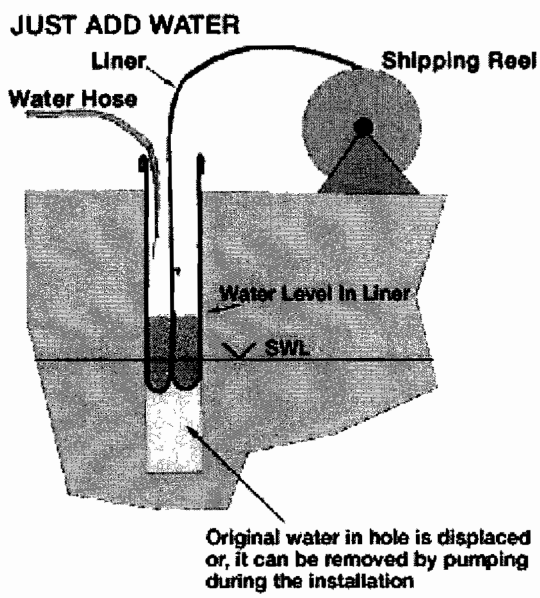
Purpose

The Water FLUTe system is a multi level water sampling system. The general characteristics are as follows:

- Quickly emplaced from a shipping reel by eversion into the hole.
- Seals the entire borehole with a pressurized flexible liner of polyurethane coated Nylon fabric. The sealing pressure is provided by excess water in the liner.
- Defines the sampling interval for each port with an exterior permeable surround called a "spacer."
- Draws the pore liquid into the central pumping system directly from the formation.
- Allows the water level for each port to be tagged from the surface
- Provides 1-3 gals, typically, from each port per stroke.
- All ports can be purged and sampled simultaneously.
- Is relatively easy to remove for repairs, replacement, etc...

Emplacement

The liner is emplaced from a shipping reel. The top of the liner is attached to the surface casing (see the drawing, "Just Add Water") and the liner is then pushed down inside the casing a short distance. Water is added to the interior of the liner, driving the liner deeper into the hole, pulling the inside-out liner from the reel. The interior water pressure on the everting end of the liner is the driving force of the installation. Once the liner is fully extended in the hole, the geometry looks like that in the drawing below for a single port system.



The installation of a Water FLUTe is affected by the depth and diameter of the hole, the relative transmissivity of the hole, the depth to the water table, and the rate at which water can be supplied to fill the liner.

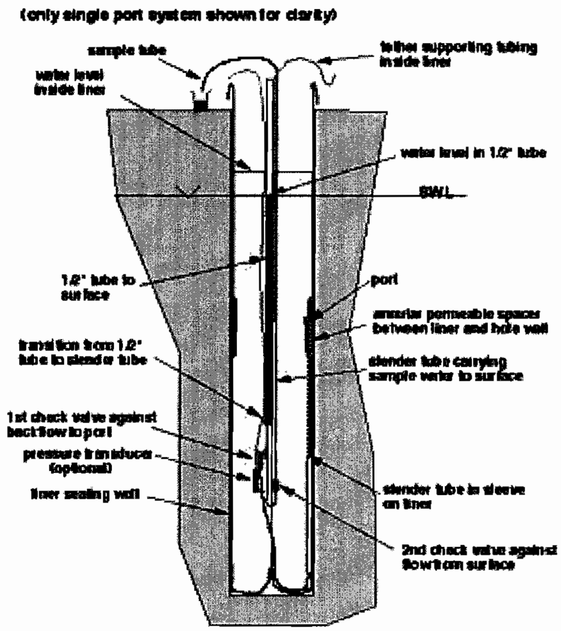
The installation procedure describes the difference when installing in a tight hole versus one that allows water to flow freely into the formation. If the hole is too tight to allow the liner to push the water into the formation, the water can be pumped from beneath the liner using a Pump Tube Liner device. In most situations, the Water FLUTe installation takes less than one day. Some installations have required less than one hour. A recent installation to 880 ft. required one day to complete.

Water FLUTe systems are often installed in uncased core holes. Installations into multi-screened cased holes are also common. Varying hole diameters are accommodated. The Water FLUTe can be installed through smaller casing into larger open holes below the casing, or into "telescoped" casing.

The liner is completely heat welded without the use of any glues. The tubing is usually Nylon. Other types of tubing can be used.

Sample pumping system

The water flows from the formation into the spacer, through the port, into the tube which lies on the inside surface of the liner. The water flows from the port via the tube, to the bottom of the hole, and then upward through a Teflon/stainless steel check valve into the "U" shaped tube. The water rises in both legs of the U tube. In the larger (1/2"id) tube, the water level can be tagged from the surface. A gas pressure is applied to the large tube to drive the sample water through the second check valve to the surface. After purging the tubing, the sample water does not contact the drive gas. The large tube and pumping hardware are not everted into the hole, but simply lowered as a tubing bundle following the liner to the bottom. Note that all the water in the hole is isolated inside the liner.

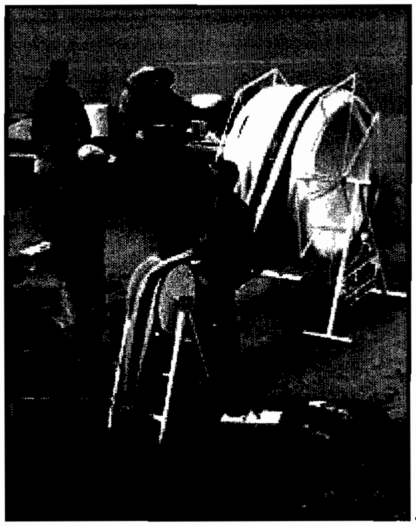


The spacer, port, tubing and pump system shown are duplicated for each port. There is no possibility of cross contamination from other sampling intervals. The liner is pressed against the hole wall by the excess head in the liner above the local water table.

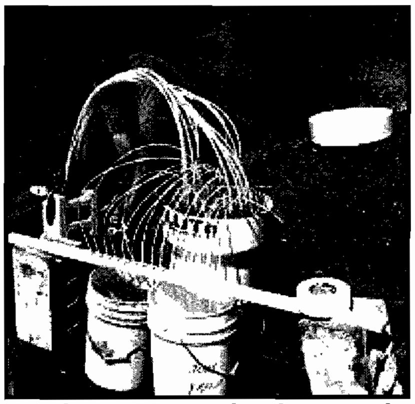
Pressure gauges are often attached to the sampling tubing just below the first check valve to measure the head in the formation at the port location. The transducer is upstream of the valves in the pumping system. The pressure transducer can be calibrated to the head measured in the sampling system with a tag line.

The experience with Water FLUTe systems is summarized at Users. The Water FLUTe systems have been installed in Ontario, MA, NY, CT, NH, ME, PA, CA, AZ, NM, and TX. Detailed installation and sampling procedures are available.. More detailed descriptions and publications are available at Publications.

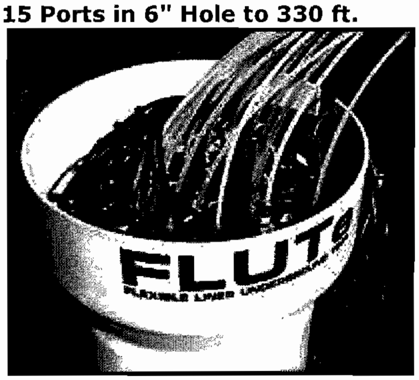
A typical installation of a 15 port system is shown in the photo. This installation took about 4 hrs., including the attachment of the surface hardware. The wellhead for the 15 port system with 15 pressure transducers is shown in the second photo. The simultaneous purging of all ports took about 5 minutes.



15 Ports in 6" Hole to 330 ft.



Purging 15 ports simultaneously



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THE COMPANY
APPLICATIONS
PROCEDURES
COMPARISONS
PUBLICATIONS
INSTALLATION SUPPORT

EXPERIENCE

Experience With FLUTe Systems

Overall

FLUTe systems have been used in the following 37 States:
New York, Maine, Pennsylvania, Massachusetts, Connecticut, New Hampshire, California, Texas, Arizona, New Mexico, Wisconsin, Idaho, Nebraska, Missouri, Indiana, Kentucky, Florida, Maryland, Utah, New Jersey, Washington, Michigan, Tennessee, North Carolina, South Carolina, Iowa, and Alabama. Plus Washington D.C..

FLUTe systems have been used in the following 5 Countries:.
Ontario, Canada, France, Great Britain, Spain, and Denmark.

Water FLUTe systems have been used in 18 states.

NAPL FLUTe systems have been used in 25 of those states.

Blank Liners have been used in all 37 states

Customers for FLUTe systems include most of the large environmental contractors plus the Dept. of Energy, Dept. of Defense, GE, Boeing, United Technologies, US Army Corps of Engineers, numerous State Environmental Departments, the EPA, and the University of Waterloo.

Seventy-five percent of our business is reorders from previous users.

Experience with individual systems

Specific References are included in the attached spreadsheet, References. The range of experience is also available upon request from FLUTe in the form of Power Point presentations on the individual systems. A single CD is available, upon request, which contains many high resolution photos, drawings, and descriptions of actual field installations of the Vadose, Water, NAPL and LAHD FLUTe systems: info@flut.com

Digital movies and VHS videos of specific installations are also available upon request, info@flut.com.

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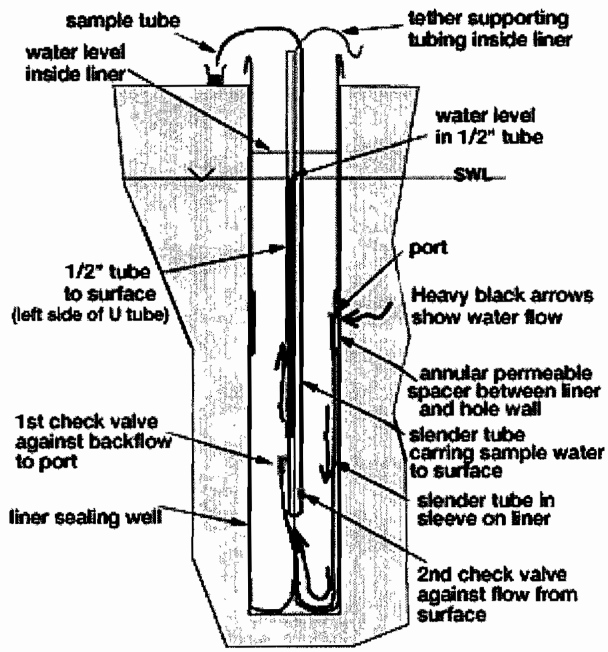
METHODS

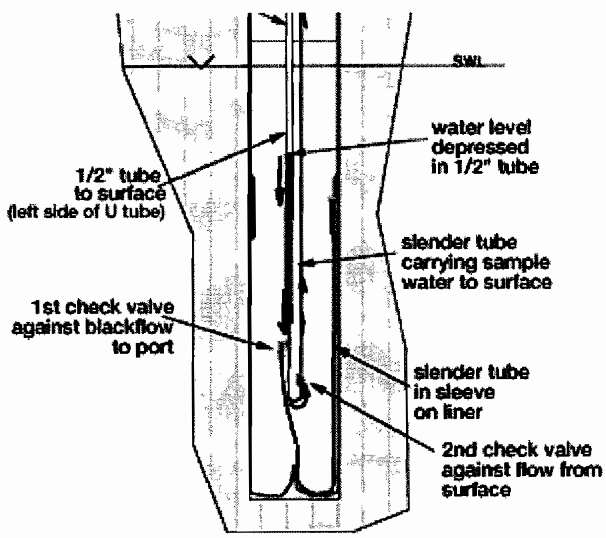
GROUNDWATER SAMPLING

The groundwater sampling method is shown in Figure 1. The hole is sealed by the pressurized liner (usually overfilled with water). The portion of the hole to be sampled is defined by the spacer attached to the exterior of the liner. The water from the formation flows into the spacer interstitial space and thereby to the port through the liner. The port is connected to a tube that carries the water to the bottom of the hole and then up to the pumping system. The water flows through the first check valve into the U shaped tube. Both legs of the U tube are filled to the level of the water in the formation, but the second check valve depresses the water level in the slender side of the U tube. A lightweight ball (Teflon) and no spring are used in the first check valve so that the water level in the 1/2"tube of the U is not affected by the valve.

Fig. 1. "Water FLUTe" valved tubing sampling system (single port system shown for clarity)



The water is pumped from the U shaped tube by the downward displacement of the water surface in the large tube. (See the drawing) The displacement is effected by applying a gas pressure to top end of the large tube. The pressure is usually applied from a compressed nitrogen bottle. The water in the large tube is displaced downward through the bottom of the U and upward through the second check valve (steel ball with spring). The water rises in the slender tube to the surface.



During the purge cycle, the water is completely displaced from the tubing and then allowed to refill. After the purge, the gas pressure is reduced to a value which will not force the free water surface to the depth of the U. The first portion of the sample water stroke is discarded (see Water FLUTe Sampling Procedure for the details).

Attributes of the sampling procedure:

- The bottom of the U tube is usually located near the bottom of the hole. This provides a very large volume of water for pumping of each port regardless of the elevation of the port in the hole.
- Because the liner occupies such a small fraction of the hole volume, there is space for relatively large and long pump tubing.
- Each port has its own dedicated pumping system.
- The U tubes are all located near the bottom of the hole and can be pumped with the same pumping pressure, simultaneously, for a great savings of the cost of sampling labor. Some 15 port systems are purged and sampled in less than one hour.
- The head for each port can be tagged from the surface with a slender electric tag line, if the water table is not below about 150 ft. from the surface.
- Pressure gauges are often located just below the first check valve for each port to monitor the discrete head response. This is useful for aquifer characterization during seasonal and forced head variations. For deep (>200ft) water tables, this is the only FLUTe method for monitoring the water level in the large tube, other than the measurement of the collected purge volume from each port.

For more information, contact us at info@flut.com.

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APPLICATIONS

MULTI-LEVEL GROUNDWATER SAMPLING

This application is met by two systems: The Water FLUTe system and the Mini FLUTe system.

The **Water FLUTe system** (1-20 ports) is for deeper applications in stable holes (e.g., core holes in fractured rock or multi screened casing in unstable media). For more information on the Water FLUTe system, go to Methods (ground water sampling) or to Water FLUTe system. Water FLUTe installation procedures can be viewed or downloaded. Water FLUTe sampling procedures are also available. Hole diameters range from 3 inches to 12 inches, or greater.

The Water FLUTe system is:

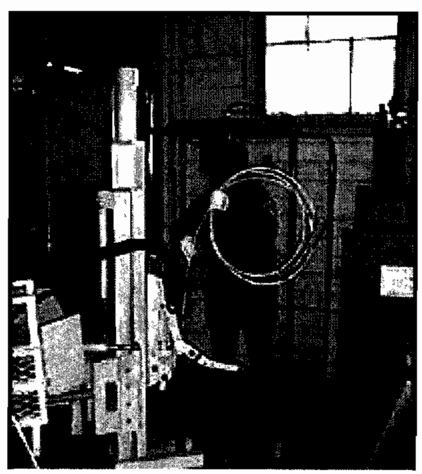
- Quickly installed,
- Seals the entire hole,
- Easy to sample, and
- Removable.

The sampling volumes are especially large per pump stroke because of the unique Water FLUTe design. The system geometry is shown in Water FLUTe systems.

The Water FLUTe system is the most popular FLUTe system. Water FLUTe use is described in Water FLUTe users. The prices for Water FLUTe are provided as a function of number of ports and hole depth at Water FLUTe prices. Powerpoint presentations on the Water FLUTe system can be mailed to you. Contact us at info@flut.com to request our Powerpoint presentations.

The **Mini FLUTe system** (1-3 ports) is installed through the interior of cone penetrometer rods or Geoprobe rods in unstable sediments.

This system is:



- Quick to install
- Well sealed in the formation by the pressurized liner,
- Easy to sample, and
- Removable.

The method is described under Mini FLUTe method. A detailed description is provided at Mini FLUTe system. Prices are available at Mini FLUTe prices. The patented liner installation technique is the same as that frequently used for the NAPL FLUTe color reactive liner.

Ask explicit questions of us at info@flut.com.

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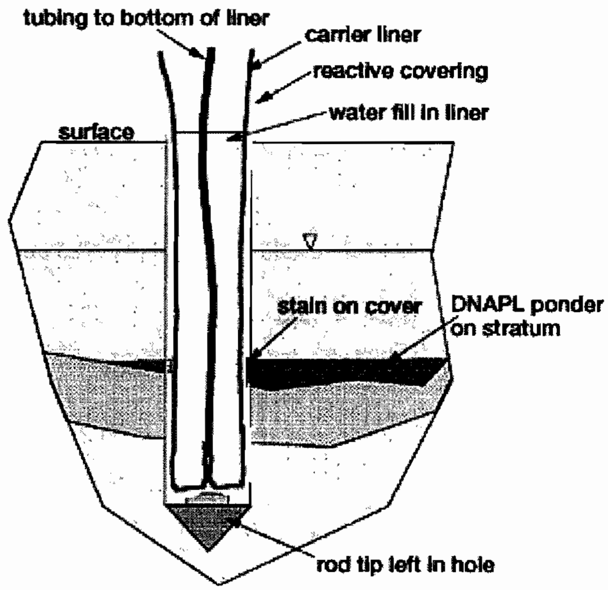
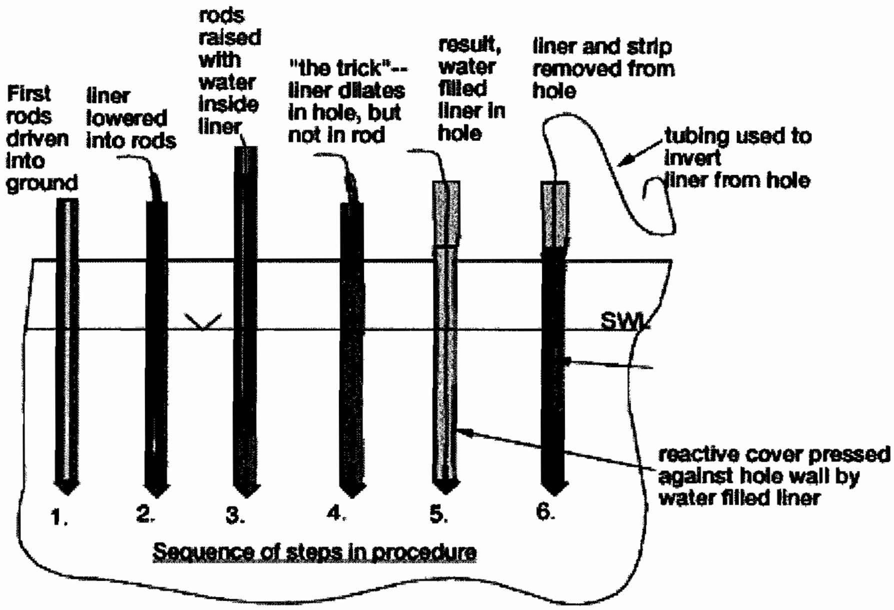
SYSTEMS

NAPL FLUTe™

The NAPL FLUTe system addresses the problem of locating layers, filled fractures or globules of pure product trapped in the formation. The approach is to emplace in a punched or drilled hole, a fabric that reacts with the NAPL to produce a very obvious stain on the fabric where it contacts the pure product. The fabric (also called a cover when emplaced on a liner) is recovered by inverting the liner from the hole. This peeling process inverts the cover and liner to allow the cover to be removed without touching the hole wall at any other place than the original placement. The emplacement methods range from installation in the interior of a push rod (e.g., a cone penetrometer or Geoprobe) to everting the liner with the outer reactive cover into a core hole. Both techniques allow the cover to be emplaced against the hole wall without contact with any other portion of the hole wall. When the liner and reactive cover are in place, they are as shown in the drawing. The excess head in the liner above the water table in the formation forces the liner strongly against the cover and against the hole wall. After the cover has reacted with the formation fluids, the tubing is lifted upwards, inverting the bottom end of the liner with the covering. As the tubing is pulled from the hole, the inverting liner follows it to the surface. After the entire liner/cover is peeled from the hole, the liner is pulled off the covering, exposing the inside surface of the cover. The stains on the inside surface are easily read for the location of the NAPL in the hole.



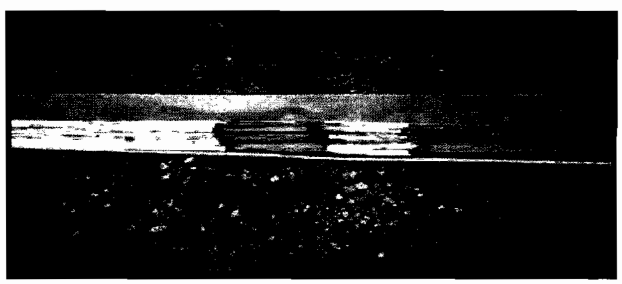
The NAPL FLUTe installation via the interior of the push rods is shown in the stepwise drawing of the procedure (shown below). The essential feature of the method is that the liner dilates to support the hole wall, but it does not dilate inside of the rod. If it did, the friction is so large as to tear the liner as the rod is withdrawn. As it works, the liner expands against the hole wall as the rod exposes the wall. In that way, the reactive cover is pressed again any NAPL in the pore space or fractures of the formation.



This technique was first used at Cape Canaveral to locate a thick layer of TCE in the coastal sediments. Since then, it has been used in many states to test for the presence of free product in the formation. Earlier versions of the reactive cover used Sudan IV. Sudan IV has been replaced with a nontoxic dye. See NAPL FLUTe users for other installation experience.

The patented method for emplacing such a large assembly of covering, liner and tube in the interior of the rod and removing it without damage is unique to this system. The reactive cover is covered by another patent pending. Research is in progress for perfection of other reactive coverings to detect other kinds of compounds in the subsurface. Contact us at info@flut.com for the most up to date procedure for this installation.

The installation into cored holes uses the technique for the everting liner installation very similar to that described in Vadose FLUTe system or Water FLUTe system. In the unsaturated zone, the liner and covering are everted into the open hole from an air pressure canister. For installations into water filled holes, the liner is everted into the hole using the "JUST ADD WATER" technique. The results from a water driven eversion into a 3" core hole are displayed here.



TCE stains from fractures in a 3 in. core hole (note the boot toes for scale)

Contact us at info@flut.com for additional information.

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APPLICATIONS

MAPPING OF DNAPLs FREE PRODUCT (undissolved phase)

A FLUTe technique, developed in concert with the Savannah River Site, is a color reactive liner that changes color dramatically in the presence of a variety of DNAPL substances. The mechanism is described at NAPL FLUTe. The color reactive cover on the outside of a carrier liner (i.e., a blank liner) can be emplaced in an open borehole or via the interior of several push rods or driven casing methods. The "trick" of this method is that the liner is removed by inversion(peeling) of the liner, with the stained cover, from the wall of the hole. The cover is thereby carried to the inside of the inverting liner where it is protected from any other contact with the hole wall as the liner rises to the surface. The stain pattern on the cover provides the exact location of the undissolved DNAPL in the hole.

This technique has been used at many sites (Users). The installation into core holes is particularly easy. The dye which is used has been changed from the toxic Sudan IV to a non-toxic substance of equal performance. Since the cover is hydrophobic, the contaminant is wicked into the cover, transporting the telltale dye with it.

In some cases, the free product does not mobilize the dye, but is still wicked into the cover and provides a dark stain and strong odor for ease of "reading" the cover.

Wicking of gasoline is dramatic, but because of the wicking process, the liner stain is not a particularly good indication of the thickness of thin layers of gasoline.

Most situations yielding strong results are conductive sands overlying clay or silt layers that cause the DNAPL to pond on the fine grain layer. Over spectacular results have been obtained in fractured rock where the DNAPL is lying in the fracture.

The color reactive material has been used alone as an indicator of DNAPL distribution in core by laying the core on top of the reactive material as the core is extruded from the core barrel. However, if the core is exposed to the air, many solvents are immediately lost and may not reach the reactive material.

Note, this technique is not intended to indicate the presence of the dissolved phase.

For more information on this technique, contact us at info@flut.com.

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APPLICATIONS

CHARACTERIZATION OF FLOWPATHS FROM BOREHOLES

The everting liner mechanism is well suited to the measurement of flow rates from the hole while the everting blank liner is being installed. This method is described in detail under methods, Characterization of flow paths from boreholes. The basis of the technique is that the sealing liner descends; it displaces the borehole water into the formation. The descending liner also seals the hole and therefore, it covers the flow paths from the hole as it descends. The descent rate is controlled by how easily the water flows from the hole. Hence, by recording the descent rate of the liner and the level of excess head inside the liner, one can deduce the effective transmissivity of the remaining hole. As each significant flow path is sealed by the liner descent, the remaining transmissivity decreases. That decrease is the transmissivity of the portion of the hole just covered. The end result is a plot of the hole transmissivity with depth. This technique is especially well suited to freely flowing holes with shallow water tables, because there is no need to consider the hanging wt. of the liner above the water level in the liner, nor the wet film cling of the liner against itself above the water in the liner. Relatively tight hole measurements are only more difficult because of the low descent rate in the hole and the long time required to measure the hole. However, experience has shown that the flow from the hole is often dominated by a few relatively free flowing fractures.

Another technique for assessing the formation conductivity is to use the recovery rate of the sampling system for each port to deduce the conductivity of that portion of the hole defined by the spacer length (see Water FLUTe system for the description of the sampling system geometry). This recovery rate is only useful if it is dominated by the formation conductivity and not by the tubing size and length. For that reason, the conductivity assessment via the recovery rate is generally limited to conductivity values below 10E-5 cm/sec. If larger tubing is used (possible in holes of greater than 6" diam.), the upper bound on possible conductivity measurements rises quickly, because of the radius to the fourth power dependence of flow in tubes.

The liner descent rate method described above is being field tested. The monitoring transducers and recording system have been built and attached to a linear capstan. The software has been written to deduce the borehole transmissivity with depth.

A patent is pending on this method and hardware.

You can contact us for the status of the field testing at info@flut.com.

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SYSTEMS

FLUTe HYDRAULIC CONDUCTIVITY PROFILER

This technique uses the blank liner installation described under everting liner mechanism to map the flow paths from the borehole as the blank liner is being installed. The method is described in detail with examples of results at Characterization of flow paths from boreholes. The results are typically obtained in 30 minutes to 2 hours and provide detail of the flow paths unavailable from straddle packer tests of the entire borehole. The blank liner used for the measurement is usually left in the hole to seal the hole against any contaminant migration via the hole.

The system consists of the basic blank liner and the ³machine² which controls the liner tension, records the depth and velocity of installation, and records the water level in the liner (the driving force) in time. From that data is calculated the transmissivity of the entire borehole and the distribution of that transmissivity in the borehole. This technique allows the identification of all significant flow paths from the borehole. The data is recorded onto a laptop into a spreadsheet which reduces the data to a transmissivity plot of the borehole.

Comparisons of this technique with straddle packer tests have shown excellent agreement and much more detailed fracture flows than can not be obtained with the typical straddle packer procedure. Comparisons with geophysical measurements and video logs show that the flows measured are related to fractures seen in the logs. However, it is also seen that some prominent fractures seen in the video logs do not have significant flow. Permeable zones are also clearly defined in the data plots

The method uses the fact that an everting liner forces the water from the borehole and sequentially covers the flow paths as it descends towards the bottom of the hole. Unlike straddle packer testing, there is no concern about bypass of the liner by leakage of the liner seal or flow in a permeable formation. There is no investigation derived waste generated by the measurement. The flow paths measured are often used to define the sampling intervals to be used for the Water FLUTe multi level sampling system which is subsequently installed to obtain water samples and head data.

For explicit questions or applications, contact us at info@flut.com.

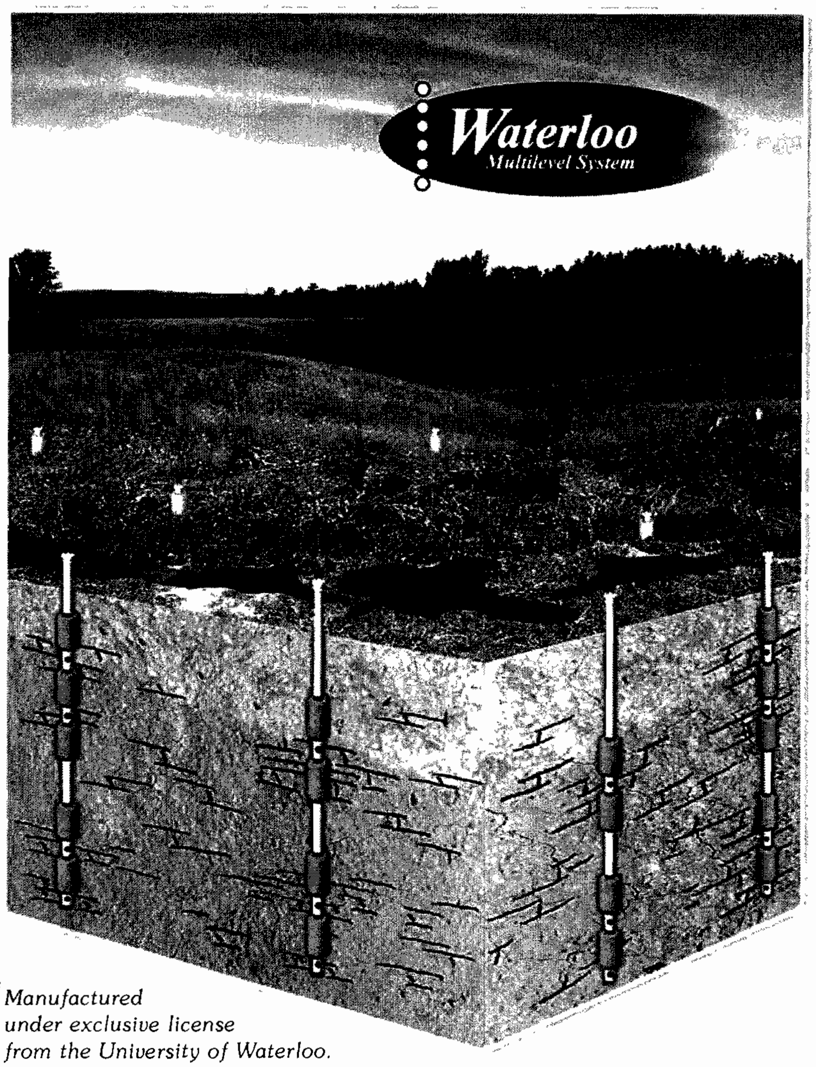
APPENDIX B

TECHNICAL INFORMATION FOR THE WATERLOO SYSTEMS

Waterloo Multilevel Groundwater Monitoring System*

The Waterloo System is used to obtain groundwater samples, hydraulic head measurements and permeability measurements from many discretely isolated zones in a single borehole.

The Waterloo System originated with Dr. John Cherry at the Groundwater Institute of the University of Waterloo in 1984. Ongoing development of the System by Solinst has taken place on a continuous basis since then, with encouragement and suggestions from Dr. Cherry.



*Manufactured under exclusive license from the University of Waterloo. Canadian Patent #1232836 U.S. Patent #5048605 & International Patents.

Detailed 3-D Data

When a number of Waterloo Systems are used at a site, they allow detailed three-dimensional groundwater information to be obtained at a reasonable cost. Fewer drilled holes are an advantage and monitoring times are reduced.

The simple modular system is customized for the needs of each project. This allows monitoring zones to be placed at desired depths using options suitable for either bedrock, overburden or combination applications and with either permanent or removable systems.

Discrete zone monitoring is the only means of obtaining accurate data for site interpretation and assessments. Transects of multilevels provide the detailed data necessary to calculate mass flux and conservatively assess risk to receptors.

Advantages

- Detailed 3D data of flow and concentrations
- Data integrity
- Reduced project costs
- Purging and sampling times reduced
- Fewer drilled holes
- Reduced site disturbance
- Variety of monitoring options

Detailed 3-D Data

- **Overburden or Bedrock Installations**
  - Allow monitoring of multiple zones in any geologic setting
- **Permanent Waterloo Packers**
  - Excellent in bedrock or cased holes
  - Engineered for permanent seals
- **Removable Hydraulic Packers**
  - Reuse at new zones or locations
  - Easy decommissioning

Why Multilevels

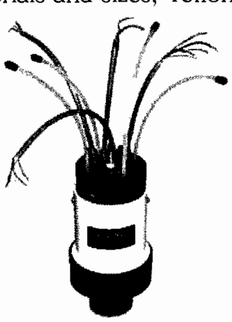
Superior quality of data is obtained when monitoring a series of discrete isolated intervals at various depths in a single borehole. The detailed information provided by Multilevels in the form of horizontal and vertical flow, in conjunction with discrete zone sampling for contaminants, is ideal for accurate site assessments.

- **Biases with Long Screened Wells**
  - Contaminant mixing over long screens masks vertical variations resulting in underestimating the aerial extent of plumes and diluting the true concentration of contaminants.
  - Ambient vertical flow within the well has potential to transmit contaminants to previously isolated zones.
- **Detailed Multilevel Data – Advantages**
  - Transects of Multilevels across a groundwater flow path provide the best data to use for Mass Flux calculations. This has proven to be an important tool for site assessments that require realistic estimates of maximum contaminant concentration/risk to receptors.
  - Optimize performance of in-situ remediation by using detailed 3-D data from a series of Multilevels. Subsequently, transects can be used to evaluate the success of the chosen remediation option and any improvements.
- **Economics**
  - Proven cost reductions for drilling and sediment disposal
  - Savings, both in field personnel time and disposal costs, when purge volumes are reduced. The discrete interval that a Multilevel port encompasses allows for smaller purge volumes, rapid responses to level changes and is ideal for low flow sampling techniques.

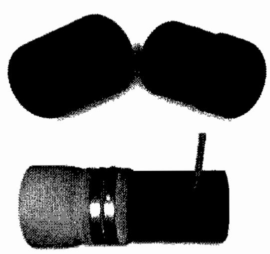
The Waterloo System

The System uses modular components which form a sealed casing string of various casing lengths, packers, ports, a base plug and a surface manifold. This allows accurate placement of ports at precise monitoring zones.

Monitoring tubes attached to the stem of each port individually connect that monitoring zone to the surface. The standard system is built on 2" (50 mm) Sch. 80 PVC to fit 3"- 4" (75 - 100 mm) boreholes and uses 3 ft. (915 mm) long packers. Stainless steel components, custom packer materials and sizes, Teflon® tubing are available.



Manifold



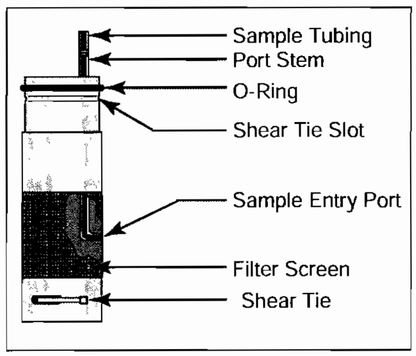
O-Ring Joints with Shear Wire

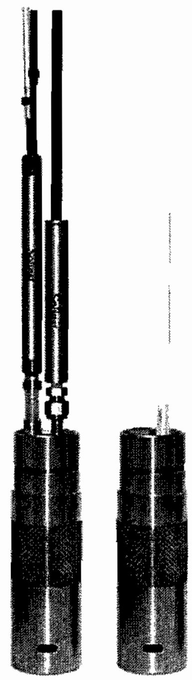
* US Patent 5,255,945 ®Teflon is a registered trade-mark of the Dupont Corporation.

Ports

Monitoring ports are constructed from 316 stainless steel. Ports are isolated by packers at each desired monitoring zone and are individually connected to the surface manifold with narrow diameter tubing. Thus formation water enters the port, passes into the stem, up into the monitoring tube attached to the stem, to its static level.

A sampling pump or pressure transducer may be dedicated to each monitoring zone by attachment to the port stem. Dual stem ports are available to allow both sampling and hydraulic head measurements from the same port. Alternatively, the monitoring tubes may be left open to allow sampling and hydraulic head measurements with portable equipment. For installations in silty deposits there are special sampling ports with extra screening to prevent silt entry into the port.





Stainless Steel Ports

Joints*

The patented method of joining components of the Waterloo System uses a nylon shear wire and an o-ring. This gives reliable, leakproof joints so that the core of the Waterloo casing string is isolated from external formation waters. Groundwater is only accessible via the port stems and attached monitoring equipment. This water-tight seal also prevents contact between packer inflation water inside the casing and the formation water outside the casing.

Manifolds

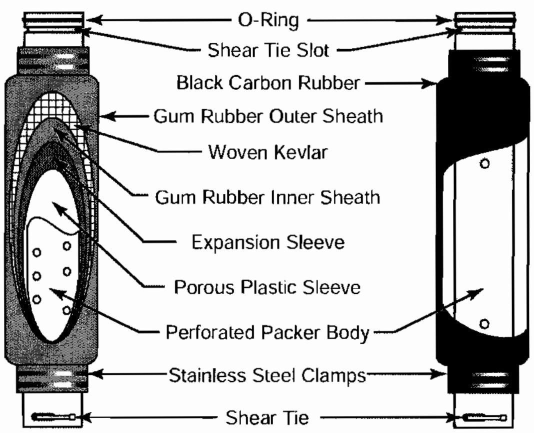
The manifold completes the system at surface. It organizes, identifies, and coordinates the tubes and/or cables from each monitoring zone.

The manifold allows connection to each transducer in turn, and a simple, one-step connection for operation of pumps. When dedicated pumps are selected, it allows individual zones to be purged separately, or purging of many zones simultaneously to reduce field times.

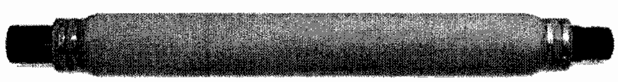
Permanent Waterloo Packers

Permanent packers ensure long term integrity of seals in cored bedrock holes and cased wells. They use a water activated expansion sleeve fitted over the perforated packer body. A layer of porous plastic distributes water evenly to the packer expansion material. A Rubber/Kevlar/Rubber sheath envelops the expansion material. The Kevlar layer provides strength to bridge across large fissures. The pliant gum rubber forms an effective seal against the borehole wall.

Water is added to the inside of the sealed casing string after installation. The water passes through the packer body into the expansion sleeve, causing the material to expand. Thus an engineered seal is permanently formed against the borehole wall.



Permanent Waterloo Packer *Removable Hydraulic Packer*

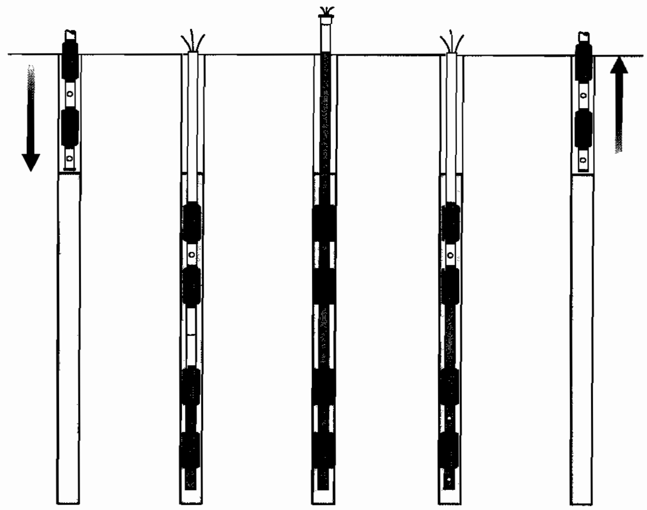


Permanent Waterloo Packer

Overburden Applications

Waterloo Multilevel Systems can be used to monitor multiple zones within unconsolidated formations, as well as in bedrock. There are three methods of System installation:

- Within hollow stem augers or temporary casing. Special screened ports are used and flowing sand formations are allowed to collapse around the System.
- Within hollow stem augers or temporary casing using standard tremie methods to place sand around the ports and bentonite seals in the annular space between the monitoring zones, as the augers or temporary casing is lifted.
- Within a cased and screened well, using packers to seal zones.



Insertion Pre-Inflation Inflated Deflated Removal

Removable Hydraulic Packers

These packers allow reuse of the system at other zones or new locations. They facilitate system maintenance and borehole decommissioning, simplify grouting of the hole and allow parts of the system to be reused.

Removable packers are made with black carbon rubber and are inflated hydraulically or pneumatically by pressurizing the interior of the Waterloo System casing string. Packers can be constructed to suit various diameters of holes.

Installation within Wellscreen/Casing

A permanent 3" or 4" casing and screen string can be installed by a drilling contractor using typical sand and bentonite placement methods. Then a Waterloo System with either permanent or removable packers can be installed within the screen and casing string, as in a bedrock borehole.

Installs Quickly

Installation of the Waterloo System is quick and easy. Starting with the base plug and lowermost sections, the components are joined together in the order required. As each new port is put into position a new monitoring tube, dedicated pump and/or transducer is connected to it. Successive components are threaded over these tubes, building the casing string, until the System is complete.

Typically, installations are completed in a day, using a 3-4 member team. Depending on the depth, a drill rig may be required. Solinst can provide a trained technician to assist with installation.

System Flexibility

The Waterloo System is extremely flexible to your design criteria. Each System is customized to suit monitoring needs, site conditions and budget constraints:

- Removable or permanent system
- Bedrock or overburden applications for groundwater or vadose zone monitoring

Packers and ports can be accurately placed to monitor each zone of interest.

Materials

For particular applications specific materials may be chosen. These may include stainless steel casing and packer bodies, and stainless steel, nylon or Teflon® tubing.

Borehole Size

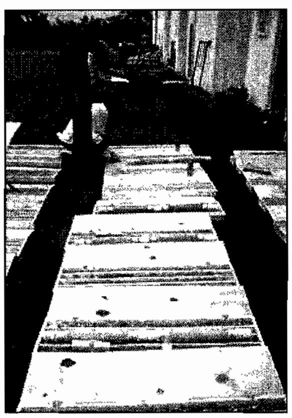
Waterloo or removable packers are designed for use in 3"- 4" boreholes (75 - 100 mm). Systems can be installed in larger boreholes using:

- Placement of sand and bentonite to isolate parts around a Waterloo casing string with no packers.
- 3-4" screen and casing, installed within a larger hole, completed by installing a Waterloo System with packers.

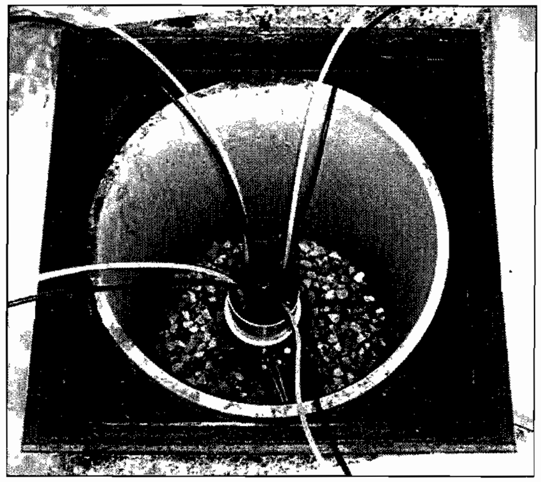
Number of Monitoring Zones/Hole

The maximum number of monitoring zones for a System is determined by the number of tubes and/or cables that will fit inside the casing string. This number is dependent on the monitoring options chosen. Systems can be designed to monitor from 2 to as many as 24 zones.

Standard 2" (50mm) Waterloo System	
Site Dependent Monitoring Options	**# Zones**
Dedicated Pumps and Transducers	8
Open Tubes Only (varies with tube size)	15
Dedicated Pumps and Open Tubes	6
Dedicated Pumps Only	12
Dedicated Pressure Transducers Only	24



Using core logs to identify placement of Ports and Packers



Multi-Purge Manifold with Transducers and Dedicated Pumps for four zone monitoring

Monitoring Options

- **Dedicated sampling pumps and/or pressure transducers**

  Each monitoring port may be fitted with a dedicated sampling pump and/or pressure transducer. This maximizes the speed with which each data set can be obtained, and avoids the need to decontaminate and repeatedly lower portable devices. The sampling pumps are suitable for sampling many types of contaminants, including VOCs.

  Purge volumes are very small. With dedicated pumps all zones can be purged simultaneously. Ports with two stems allows a dedicated pump and a transducer to be placed at exactly the same level.

- **Open tubes**

  The most basic version uses open tubes attached to each port. This option allows monitoring with a portable sampler and a narrow diameter Water Level Meter. This provides a very economical and flexible multilevel monitoring device.

- **Mix of open tubes and dedicated equipment**

  A third option is to choose a mix of open tubes and dedicated equipment in different zones. This method combines the advantages of less expensive portable equipment for shallower zones (i.e. 100 ft., 30 m) and the more time efficient dedicated equipment for deeper zones.

- **Water level monitoring only**

  The System can comprise pressure transducers only, for pressure monitoring in up to 24 discrete zones.

Dedicated Sampling Pumps

Dedicated equipment reduces the time and effort required to obtain data, as equipment is not lowered down the borehole and purge volumes are reduced. It gives significant cost savings and avoids cross contamination.

For long term or frequent sampling Waterloo Systems most commonly use the gas drive, Solinst Double Valve Pumps with stainless steel and Teflon® valves. A pump is connected directly to the stem of each port and dual line polyethylene or Teflon® tubing connects the pump to the wellhead manifold.

Both automatic and manual pump control units are simple to use. They have quick-connect couplings with only a single connection to the manifold required. Samples from all levels are easily and rapidly obtained. Purging from some or all levels simultaneously is accommodated by the multi-purge feature of the manifold.

Collecting a Sample from a Dedicated DVP

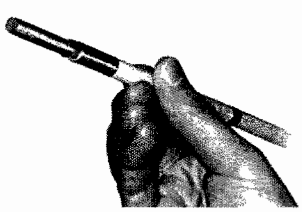
Low Flow Purging and Sampling

Purge volumes are very small due to the small annular space and tubing diameters used in the system. Consequently sampling is rapid, even though flows are low, especially with dedicated pumps when all zones can be purged simultaneously.

Dedicated Bladder and Double Valve Pumps, (DVP), as well as a portable DVP are ideal for use when low flow sampling and purging techniques are desired.

Portable Micro Double Valve Pump

The Micro Double Valve Pump (Micro DVP) provides high quality samples, uses coaxial Teflon® tubing, and is small enough to fit in 1/2" (13 mm) ID tubing. The unique combination of flexibility and size make the pump ideal for sampling at depth in small flexible tubes.



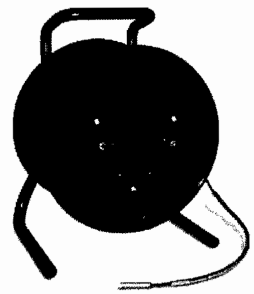
Model 408M Double Valve Pump

Taking pressure measurements with Model 404 Geokon Vibrating Wire Readout

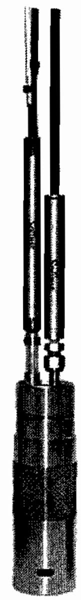
Dedicated Transducers

Dedicated pressure transducers allow rapid and accurate measurement of temperature and total water pressure. Unless static water levels are shallow, transducers are the preferred method of water level measurement, both from an efficiency and an accuracy point of view.

The transducers chosen for use in the Waterloo System are vibrating wire transducers, which are very accurate and rugged. They have superior long term operation with minimal drift over time. They can be read with a manual readout, or with a datalogger which can provide remote, unattended monitoring and telemetry, if desired. Transducers are available with pressure ranges from 50 psi to 500 psi. (7.25 kPa to 72.5 kPa).



Model 102, P1 Water Level Meter



Dedicated Sampling Pump & Transducer

Portable Monitoring Equipment

Water level measurements can be made in Waterloo ports fitted with an open tube using the narrow, Solinst Model 102, P1 Water Level Meter. It has a weighted, flexible probe, 1/4" OD by 1.5" long (6.35mm x 38 mm).

Sampling may be performed in open tubes using a Mini Inertial Pump, Micro Double Valve Pump, or a Peristaltic Pump.

® *Teflon is a registered trade-mark of the Dupont Corporation.*

Designing Your System

The options chosen for each System will be site and application specific.

Each design is dependent on:

- Zones of interest
- Geology of the site
- Monitoring methods preferred
- Cost considerations
- Borehole depth, diameter and type

Refer to the drawings below, then select the type of installation that suits your project. Consider the size and depth of each borehole, and whether casing is to be present. Decide if permanent or temporary Systems are preferred, the number of zones and depth of each zone per System, the monitoring options preferred, and any special materials required.

During development of your plans, the Solinst technical staff will be pleased to help evaluate the options and customize a System that best suits your needs.

Projects

Waterloo Systems have been used to monitor:

- Salt water intrusion
- DNAPL & LNAPL spill sites
- Industrial cleanups
- Waste disposals/landfills
- Pipeline leaks
- Soil gas surveys
- Dam leakage/rehabilitation
- Contaminant identification/cleanup

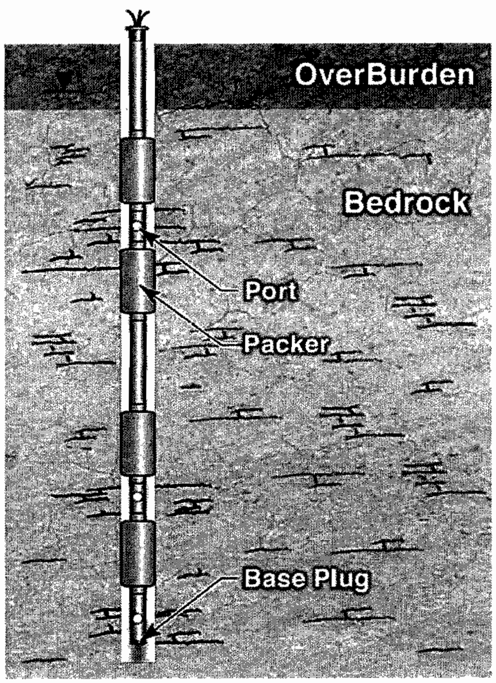
Applications

The Waterloo System has been specified by various industries and consultants for numerous sites across the United States, Canada and overseas. Waterloo Systems have been specified and approved at several sites with Superfund or RCRA designations and in each of the U.S. E.P.A. regions.

The System has been used for:

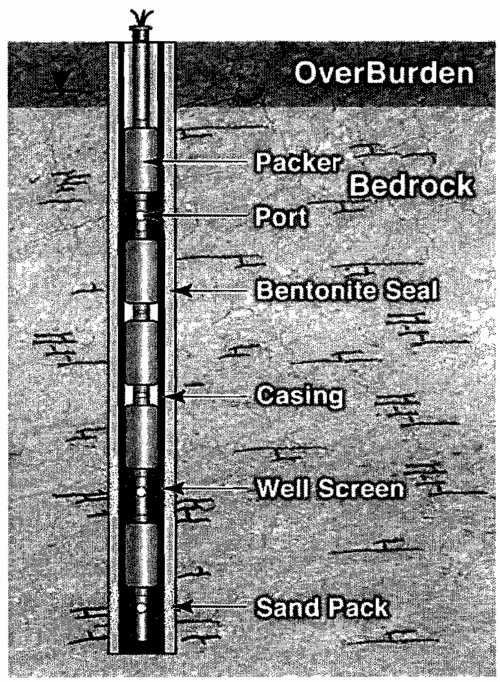
- defining groundwater flow patterns
- performance monitoring of pump and treat systems
- identification and determination of spatial distribution of contaminants
- early warning system/detection of migrating contaminants

Bedrock



Permanent or Removable Packers in Cored Hole

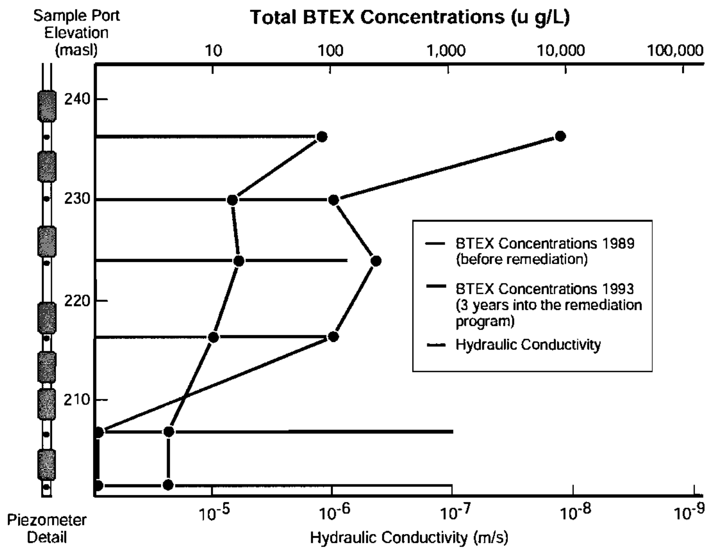
Bedrock and/or Overburden



Permanent or Removable Packers in Casing or Well Screen

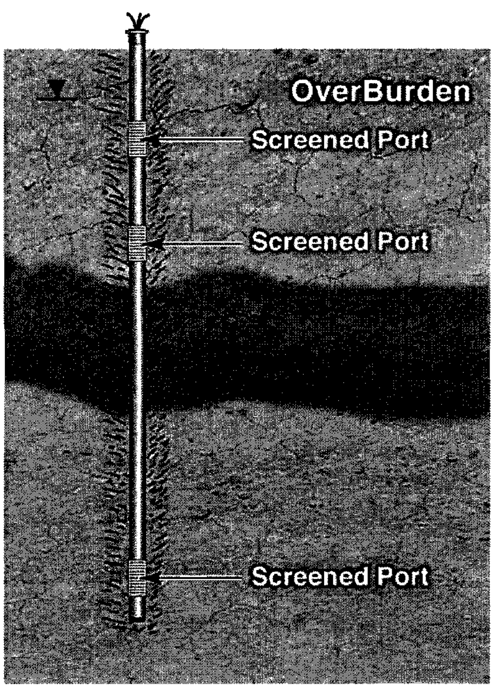
Reliable Data

The effectiveness of the Waterloo System is proven by its ability to accurately and repeatedly obtain pressure and groundwater chemistry data from several distinct zones in a single borehole. The data set below shows a decrease in Total BTEX contamination due to ongoing pump and treat operations at an oil pipeline leak.



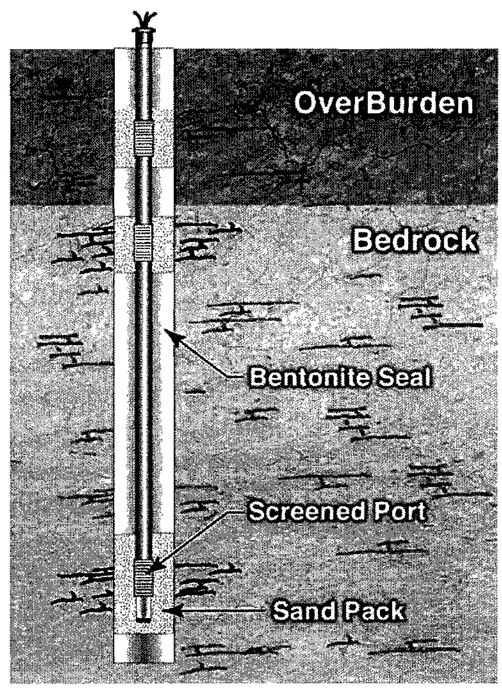
Underground oil pipeline leak assessment. Three 150 ft. (45m) installations. Two point rising head permeability tests were conducted in each interval of the Multilevel System. (See diagram showing contaminant distribution at left.)

Overburden



Direct Burial: Formation Collapse with Screened Ports

Bedrock and/or Overburden



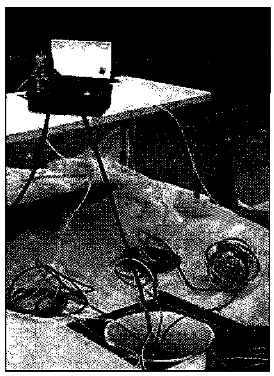
Direct Placement: Sand and Bentonite with Screened Ports

Waterloo Systems comprised entirely of stainless steel casing, packers and ports with Teflon-lined tubing were used to monitor contaminant flow in this bedrock application.

Contaminant investigation at a U.S. Air Force Base. Waterloo Systems installed to 700 ft. in overburden using screened and cased wells. Up to 6 zones per hole with dedicated pumps and transducers.

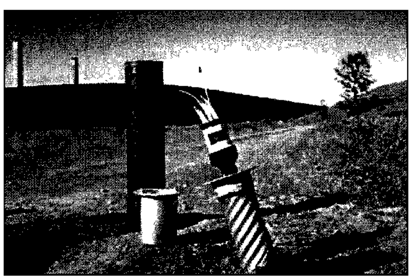
Detailed investigation of PCE delineation in carbonate bedrock. A cost analysis of the 14 Waterloo Systems compared with nested piezometers indicated savings both on the capital costs and on the on-going monitoring.

Landfill site over fractured granite, monitored with five Waterloo Systems. Each System comprised of dedicated Double Valve Pumps and Pressure Transducers in 4-6 intervals to depths of 275 feet (84m). The Multi-Purge Manifold allowed the monitoring of 21 zones to be completed in less than 2 days.



An EPA regulated site in Northeast, USA. This multilevel array allowed a sampling team to purge and sample from 40 monitoring zones across 10 borehole locations in just 4 days. These Waterloo Systems were installed in overburden using preinstalled casing.

750ft. (230m) Waterloo System installation for a deep tunnel assessment study. Three zones monitored with dedicated Double-Valve Pumps and pressure transducers. Picture shows technician obtaining pressure measurements and groundwater samples with portable readout and pump control unit.



An investigation of hydraulic properties beneath a large waste site. Waterloo Multilevel Systems were chosen to allow water quality sampling and to help determine the zones of highest permeability within the aquifer.

A large Midwestern USA research project studying agricultural effects on water quality. 22 Waterloo System installations with 3-4 zones each were installed to depths of 24-60 ft. (7.3-18.3 m) in overburden. Dedicated Double Valve Pumps and Peristaltic Pumps were used.

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APPENDIX C

TECHNICAL INFORMATION FOR THE TRIPLE TUBE HQ CORING METHOD

Core Barrel - HQ3

Boart Longyear offers a field proven standard HQ3 core barrel for use with HQ/HRQHP rods. It consists of the head assembly (item 1), inner tube components (items 2-10), and outer tube components (items 11-16). The In-The-Hole Tools Product Manual and core barrel Safety Poster are included with all core barrels.

Triple-tube core barrels are commonly selected when drilling coal, clay bearing or highly fractured formations. A second inner tube (split lengthwise) is contained inside the standard inner tube. The core ejection piston protects the core from pressurized drilling fluid when the split inner tube, containing the core sample, is pumped out of the standard inner tube. Upon removal, one half of the split tube is lifted off to reveal the undisturbed core sample.

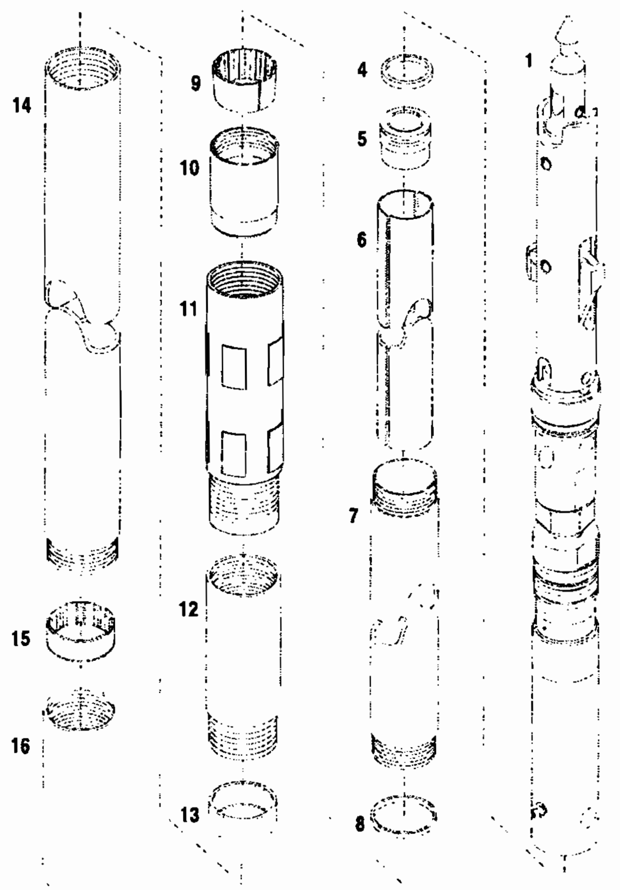
⚠WARNING All head assemblies are supplied with landing indication installed. Refer to the Head Assembly section.

How to Order:
To order a standard core barrel:
- Select a 1.5 m/5 ft or 3.0 m/10 ft core barrel part number.

Options:
There are alternatives to the standard core barrel which are indicated by a "■". To view these options refer to the head assembly and/or outer tube components sections.

How to Order:
To order a non-standard core barrel:
- Select a 1.5 m/5 ft or 3.0 m/10 ft core barrel part number.
- List all optional parts and part numbers from the head assembly and/or outer tube components sections.

NOTE: For information on packaging and assembly, refer to the packaging and/or assembly sections.



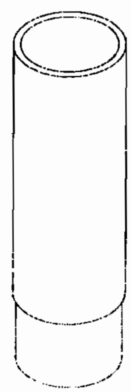
Core Barrels				kg	lbs
1-18	3542948	HQ3 Core Barrel 1.5 m / 5 ft		—	—
1-18	3542949	HQ3 Core Barrel 3.0 m / 10 ft		—	—

Standard Configuration				Qty
1	3542941	HQ Head Assembly*		1
2	26517	Pump-Out Adapter, 3/4" NPT-F**		1
3	26662	Piston Plug**		1
4	20651	O Ring		1
5	26510	Core Ejection Piston		1
6	26512	Split Tube, 1.5 m / 5 ft		1
6	26513	Split Tube, 3.0 m / 10 ft		1
7	25258	Inner Tube, 1.5 m / 5 ft		1
7	25236	Inner Tube, 3.0 m / 10 ft		1
8	26515	Stop Ring		1
9	26516	Core Lifter, Fluted		1
10	26514	Core Lifter Case		1
11	62765	HQ Conventional Locking Coupling	■	1
12	25241	Adapter Coupling		1
13	25242	Landing Ring		1
14	25259	Outer Tube, 1.5 m / 5 ft	■	1
14	25243	Outer Tube, 3.0 m / 10 ft	■	1
15	44408	Inner Tube Stabilizer		1
16	25245	Thread Protector		1
17	3541994	ITHT Product Manual (not shown)		1
18	306390	Safety Poster (not shown)		1

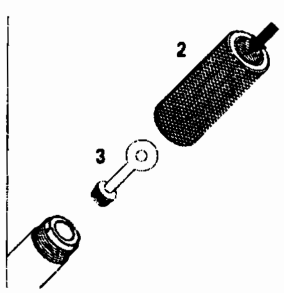
■ Additional options available.

* See the head assembly section for a detailed configuration and available options.

NOTE: Refer to the Tech Data section for technical specifications and the ITHT Product Manual for additional operating information.



Inner Tube Loading Sleeve, reference only. See Tools section.



** These items are required to pump the core out of the inner tube. Remove the head assembly from the inner tube, insert the piston plug and thread the pump out adapter on to the inner tube.

Fluid pressure supplied by optional hand pump group (p/n 26738) or pump-out group (p/n 26742). See Tools section.